the review of
POPULAR ASTRONOMY

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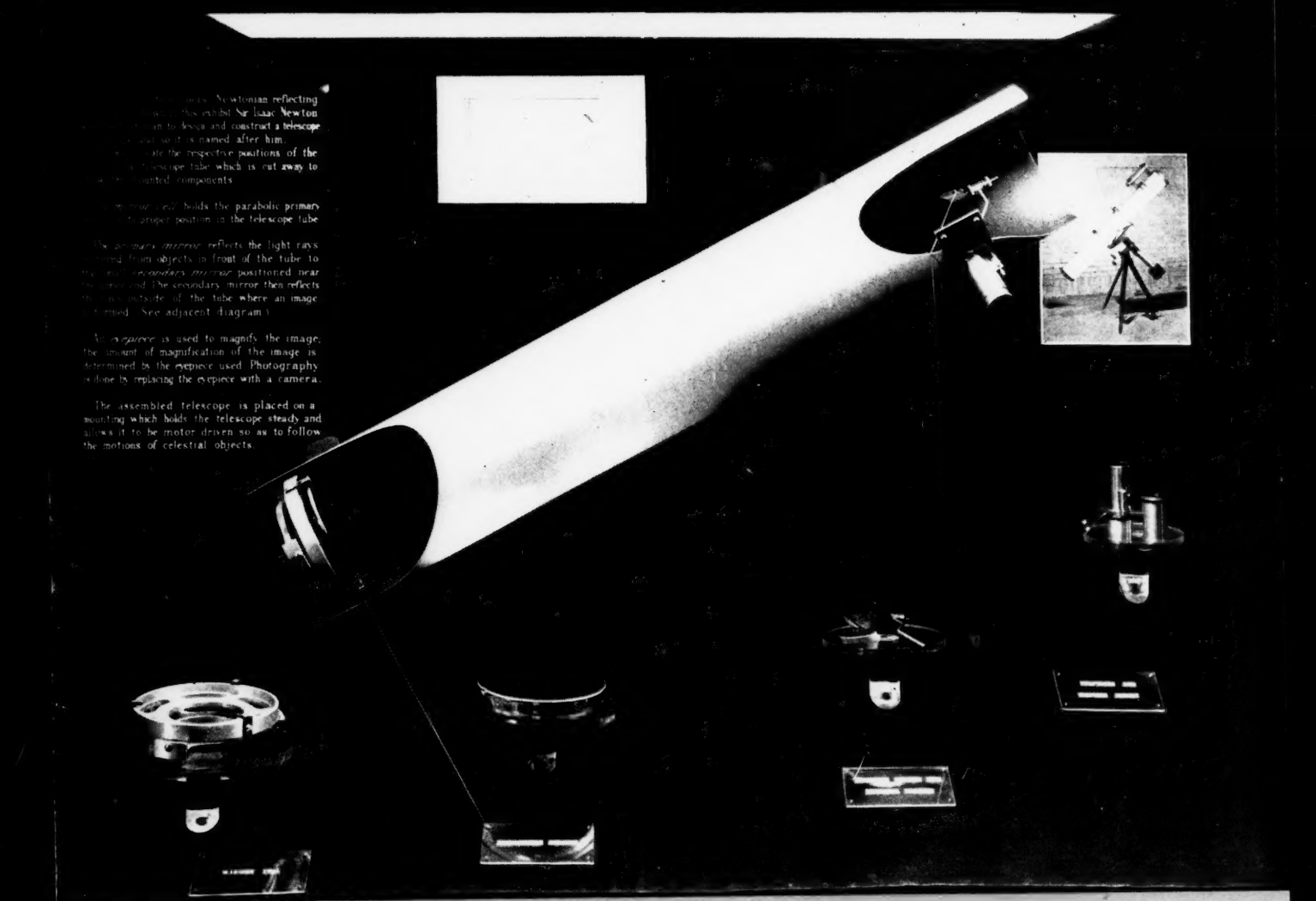

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NOVEMBER • DECEMBER
VOL. LV NO. 514 • 50c
1961

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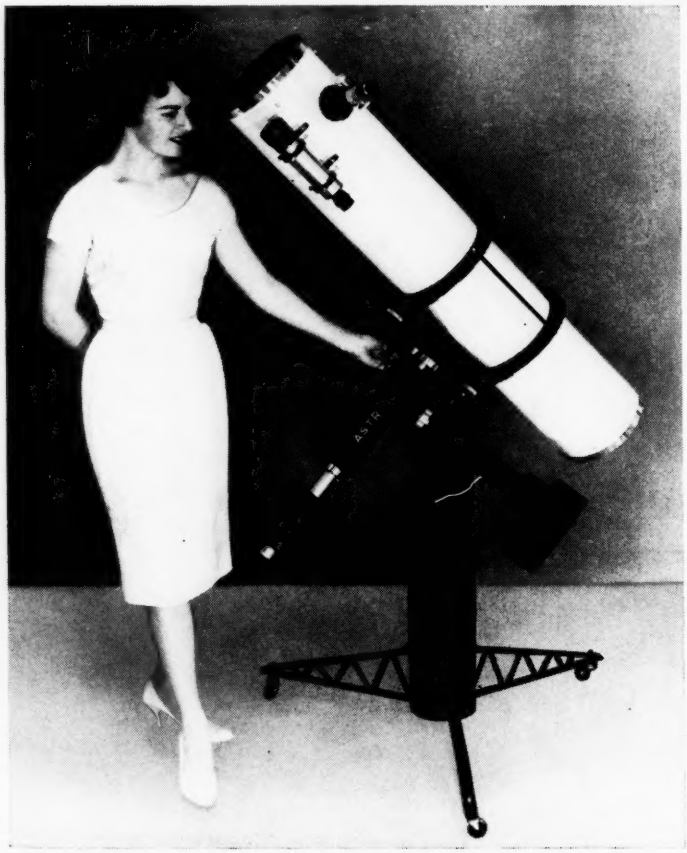

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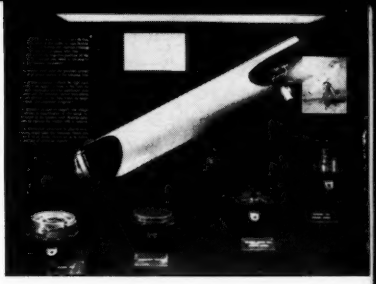
the review of POPULAR ASTRONOMY



NOVEMBER-DECEMBER 1961
VOL. IV WHOLE NUMBER 514

COPPER CURTAIN IN THE SKY

IN A TIME of larger concerns, the launching of the much heralded Project West Ford (Project Needles) on Oct. 21 would seem to be a minor consideration. Yet, just as we proceed quietly about our business of living against a shaky background of international tension, so must we continue to react in our own ways to other less obvious threats to our future. Whether the orbiting of an encircling band of tiny wire dipoles constitutes a threat to the future of astronomy, we cannot tell.

However, the very fact that we do not know gives us license to express our concern and ask a few questions. The sky above us is one of the last areas of public domain. As amateur astronomers, we have a vested interest in the sky. Many of us have extra-legally but sincerely "staked a claim" to a small segment of it. We wonder if it is being violated.

What is Project West Ford? Is it a threat? We will find out soon, perhaps. It is 350,000,000 tiny copper dipole antennas, launched into an orbit about 2,000 miles above the earth. After two months the little dipoles, each in its own separate orbit, are expected to form a complete band about the earth some five miles across that is designed to reflect radio waves for international communications.

To our knowledge, no technological project (this is not an experiment of pure science) has been so widely condemned by responsible bodies of scientists. The American Astronomical Society, the International Astronomical Union, and the International Scientific Radio Union (URSI) have all passed formal resolutions expressing concern over the possible "contamination of space" which Project West Ford might cause. Radio astronomers fear that their faint "signals" from space may be filtered out or scattered by this belt. Optical astronomers, especially in the fields of photography and photoelectric measurement, are concerned about a possible brightening of the night sky—a matter which also concerns us.

Despite these expressions of concern from the world's scientific bodies, the President's Science Advisory Committee and the National Aeronautics and Space Council announced, in a rather ironic coupling of statements, (1) that the metallic belt would not obscure the astronomer's view of the heavens, and (2) that the U. S. would launch no more belts until results of the experiment had been fully evaluated. Now, it is quite likely that this particular launching of dipoles will behave as planned — or hoped — and will be termed a success from all points of view.

But—success breeds success. More launchings follow, with swarms containing billions of reflecting wires banding the skies in stable orbits. The night sky brightens; the still clumsy but ever-reaching fingers of the radio astronomers become entangled in spurious radio noise. By then, it is too late, and generations of scientists are rendered semi-sterile by a "copper curtain" in the sky. We will have, perhaps, a dependable system of international radio communications. But what will we have to talk about?

Our concern should be with Project West Ford II or III. As amateurs of astronomy, we share a common heritage with the earliest curious man. Could the great strides taken since the first Neanderthal Man looked upward in awe be wiped out by a thoughtless, narrow gesture by modern Technological Man? We don't know yet. And the Air Force didn't know for sure when it launched Project West Ford on Oct. 21, 1961.

D.D.Z.

COVER PHOTOGRAPH
Photo of 6-inch telescope display at Adler Planetarium in Chicago courtesy of Robert Johnson, Director.

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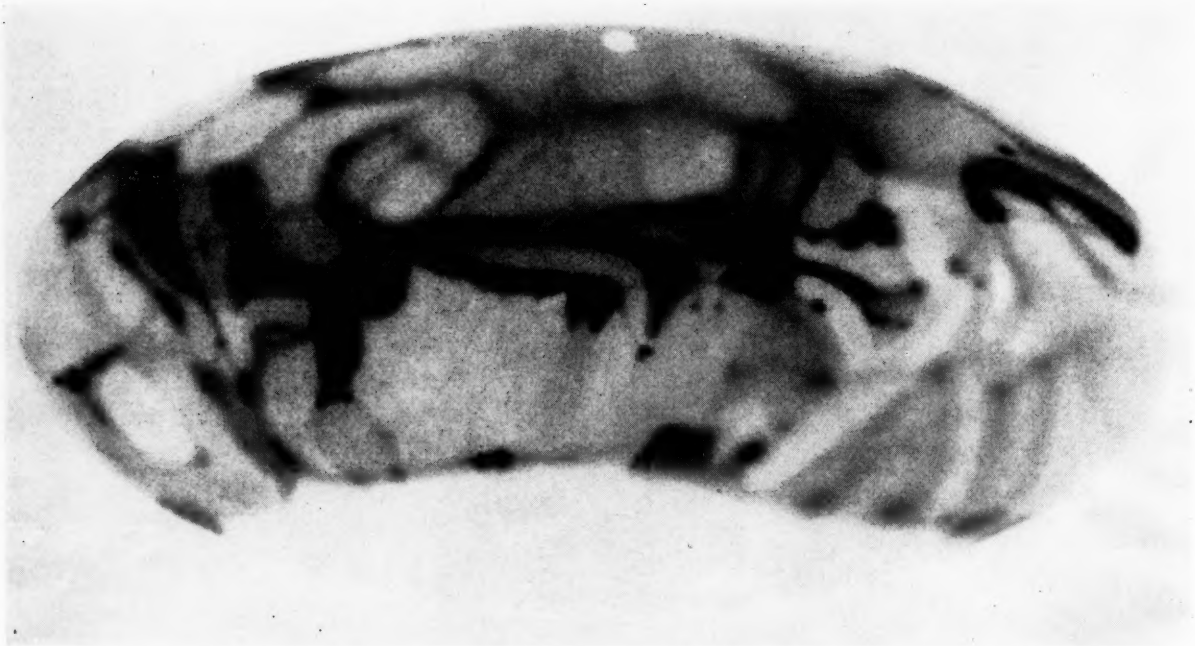


This map of Mars is based on observations made by Dr. de Vaucouleurs in October-November 1958 with the 24-inch refractor of the Lowell Observatory, Flagstaff, Ariz. The positions of well-defined points on this new may of Mars incorporate the most accurate measurements of experienced observers during the past 50 years. North is at the top and 0° Martian longitude is on the central meridian (marked by the dark and forked Sinus Meridiani) in this map, which is drawn on the Aitoff equal-area projection. Final art work was done by James Roth.

MAPPING THE PLANET MARS

DR. GERARD DE VAUCOULEURS
McDonald Observatory
and University of Texas

THE PLANET MARS as seen through a large telescope when the seeing is good is one of the most fascinating sights offered to the visual observer. The white polar caps, the reddish desert regions, the delicate pattern of the sky areas—and between them the elusive shadows and streaks which break the monotony of the bright desert expanses—form one of the most intriguing telescopic views in the Universe. Here the patient observer with a trained eye, a critical brain and a skillful hand can record a surprising amount of fine detail which no larger reflector has yet photographed.

There are very few photographs in existence which record as much Martian detail as can be seen by an experienced observer through a 10- or 12-inch refractor of first-class quality, when the seeing is close to perfection. Most of the routine photographs secured with 24-inch refractors and larger apertures at the Lick, Lowell, Lamont-Hussey, Pic du Midi and other observatories do not show more detail than can be seen in a 6- to 10-inch refractor of 8- to 12-inch reflector with good seeing. Photography has, however, the advantage of objectivity; it must be admitted that many visual observers have failed notoriously in this respect. An obsession for fine, elusive detail at the threshold of visibility and a misdirected ambition to see the wonderful (and to a large extent illusory) network of "canals" depicted by some overenthusiastic workers half a century ago are the most common pitfalls for the inexperienced observer.

The fine structure of the details of Mars will soon be resolved unambiguously when the first interplanetary probes equipped with television cameras will swoop close to the mysterious planet and transmit to earth the first high-resolution pictures of another planet. According to present plans this may well happen within three or four years. However, a few high-resolution views of Mars or of parts of it will not close the subject. Indeed, they will merely mark the first step in the process of reconnaissance of our neighboring planet which will eventually culminate in the direct exploration of the Martian surface and atmosphere by human crews. The first requirement of this exploration is a reliable map of the planet. Even the proper interpretation of the close-up reconnaissance photographs soon to be taken from probes requires that they be identified and located on the best possible map of Mars that can be established from existing visual and photographic observations with earth-bound telescopes.

Anticipating this coming need of the space exploration program, a project was started some three years ago by the writer, then at Harvard Observatory, to develop a modern, up-to-date map of Mars of the highest possible geometric accuracy. The first step in the preparation of such a map is to derive a set of accurate

This earlier key chart of Mars by Dr. de Vaucouleurs, based on visual and photographic observations made during the favorable oppositions of Mars in 1939 and 1941, can be used to identify markings on the Mars map at left. Although the Mercator projection is used here, the Sinus Meridiani (Mars' "Greenwich") is at center as in the Mars map. Key chart reproduced from "The Planet Mars" and "Physics of the Planet Mars" (Faber & Faber, London; Macmillan, New York), both by Dr. de Vaucouleurs.

planeticentric coordinates for a sufficient number of well-defined points of its surface. There are, of course, in existence a number of maps of Mars and lists of Martian (areographic) coordinates, based on the observations of one or more observers at one or more oppositions. The best is still the map prepared by the French astronomer E. M. Antoniadi and published in 1930 in his book *La Planète Mars.* A more recent map based on visual and photographic observations in 1939 and 1941, published by the author in *The Planet Mars* and in *Physics of the Planet Mars,* is reproduced here. Other maps and coordinates lists have been published by G. Fournier in France, W. H. Pickering in America, M. Maggini in Italy, Ebisawa in Japan (all from visual observations), and by R. Trumpler of Lick Observatory and H. Camichel of the Pic du Midi Observatory from photographs.

A detailed comparison of these various maps and lists of coordinates discloses great discrepancies, often in excess of five or even ten aerocentric degrees; one degree on Mars corresponds to 60 kilometers (37 miles). At present we do not possess areographic coordinates on one homogeneous system for the establishment of a standard map of sufficient accuracy to meet the immediate needs of the space program. Moreover, seasonal and secular variations of the Martian topography adds to the confusion.

THE CURRENT MARS MAPPING program has been supported since 1958 at Harvard Observatory by the Cambridge Research Laboratories of the Air Research and Development Command of the U. S. Air Force, at the University of Texas in Austin by the Applied Research Division of General Dynamics (Convair-Fort Worth), and at the Jet Propulsion Laboratory in Pasadena by the California Institute of Technology. The plan of attack has progressed simultaneously on three fronts:

1) We reviewed all the lists of areographic coordinates Kojan published since 1909 and prepared, with the assistance of Mr. R. Wright and of Mrs. O. Kojan at Harvard Observatory, a compilation of the 49 different sources available for the three cycles of Martian oppositions from 1909 to 1954, during which 21 observers contributed a total of 2,300 values (from over 12,000 independent measurements) for 586 points of the Martian surface (307 from visual observations, 429 from photographic observations, with 150 in common). This material was published at Harvard in December 1960. The raw data have been transferred to IBM punch cards for eventual statistical analysis. A preliminary analysis of systematic errors in longitude was also published from Texas in December 1960. A detailed discussion of systematic errors in both coordinates, with a preliminary reduction to a standard system, was carried out during the summer of 1961 in Texas and in California with the assistance of Mr. H. Ables and of Mrs. V. Wittasek. This work is now continuing in Austin.

2) We secured new observations during the opposition of 1958 with the 24-inch refractor of the Lowell Observatory at Flagstaff, Arizona. A brief description of the observations was published in August 1959 and areographic coordinates measured by Mr. R. Wright on 32 drawings were published from Harvard in February 1961. Maps of Mars and a globe based on these observations and coordinates have been prepared by Mr. J. Roth, whose work is reproduced with this article.

Older observations secured with the 8-inch refractor of the Péridier Observatory, Le Houga, France, during the favorable opposition of 1941 were recently measured in a similar manner by Mr. Wright and the data will shortly be transferred to punch cards prior to statistical reduction.

3) We obtained two excellent series of photographs generously communicated respectively by Dr. W. S. Finsen, director of the Union Observatory, Johannesburg, South Africa,

For a realistic representation of the surface features of Mars, Dr. de Vaucouleurs has had the maps transferred to a globe. These photographs of the Mars globe show the planet with different Martian longitudes on the central meridian. The globes were made by James Roth, who worked under the supervision of Dr. de Vaucouleurs. (A previous sample of Mr. Roth's work appeared on the cover of the March-April 1961 issue of this magazine.)

and by Dr. R. B. Leighton of the California Institute of Technology, Pasadena. Dr. Finsen's photographs consist of about 100 composite transparencies from films taken by him with the 27-inch refractor at Johannesburg in 1954 and 1956; measurement of these composites has recently been completed by Dr. C. S. Yü, of Hood College, Maryland, as part of the Harvard project; transfer to punch cards and statistical reduction will follow. Dr. Leighton's photographs were black-and-white enlargements from his remarkable Kodachrome movies of Mars taken in 1956 with the 60-inch reflector at Mount Wilson, which was diaphragmed to 20 inches by an eccentric aperture. Some of the photographs of August 23, 1956, taken during a period of near perfect seeing, are among the best on record, and the amount of fine and delicate detail visible is truly amazing (needless to say no narrow, linear "canals" appear on these photographs). Out of some 13,000 images we selected the best 7,000, from which about 750 enlarged composite transparencies were prepared at Harvard by Mrs. L. Hudson, who is now measuring them in great detail. As of the summer of 1961, over one third of the collection had been measured and work is continuing.

Our study of areographic coordinates has brought to light several systematic effects. The most important and best understood is a phase effect in the Martian longitudes measured on drawings and photographs; before opposition the measured longitudes are too small, after opposition they are too large. The amplitude of the variation is about 2 or 3 degrees, i.e., the apparent longitudes of the Martian markings vary by as much as 5 or 6 degrees in the course of an apparition. This effect is due to the asymmetrical illumination of the disk of Mars before and after opposition, which causes the apparent central meridian to be shifted away from the terminator toward the Martian west before opposition, toward the east after opposition. On more than one occasion observers in the past have announced that the longitude of the central meridian of Mars, listed in the *American Ephemeris*, was in error by 2 or 3 degrees; if they had waited until past the opposition they would have observed a reversal of the error. This phase effect was first clearly established some twenty years ago in my reduction of the observations of the opposition of 1939 made by members of the Mars Commission of the French Astronomical Society. A more detailed study of our new data fully confirms this finding and, in addition, we now find that the effect is also present in the photographic observations of H. Camichel at the Pic du Midi.

A second correction must be applied to the Martian longitudes published between 1909 and 1959 to take into account a revision of the rotation period of Mars. The longitude of the central meridian of Mars listed in the *Ephemeris* depends on a zero point, the adopted value of this longitude (344°.41) at a certain time (January 15.0, 1909), and on a value for the period of rotation of Mars (24h 37m 22.654s). While the zero point is arbitrary, the period of rotation always remains subject to improvement. A thorough discussion of times of transits of Martian markings across the central meridian of the disk observed between 1704 and 1952 was published in 1953 by J. Ashbrook, who concluded that the rotation period used in the *Ephemeris* was too short by 15 milliseconds, i.e. the true sidereal rotation period of Mars is 24h 37m 22.699s. This minute difference, adding up day after day, has a cumulative effect of over one degree of longitude after 50 years. This is too large to be neglected; beginning with 1960 the longitudes of the central meridian of Mars given in the *American Ephemeris* are computed with the same zero point as before, but with Ashbrook's value of the rotation period of Mars. In our reduction of the areographic longitudes for the period 1909 to 1958, we have made a similar correction to eliminate the small error due to the use of the old rotation period.

Finally, a third correction may be applied to take into account the irregularly increasing difference between Ephemeris Time (the uniformly flowing time scale defined by celestial mechanics) and Universal Time (affected by the irregularities of the rotation period of the Earth) used in the observations. The cumulative difference between 1909 and 1958 amounts to about 30 seconds of time, corresponding to 0°.1 only in the

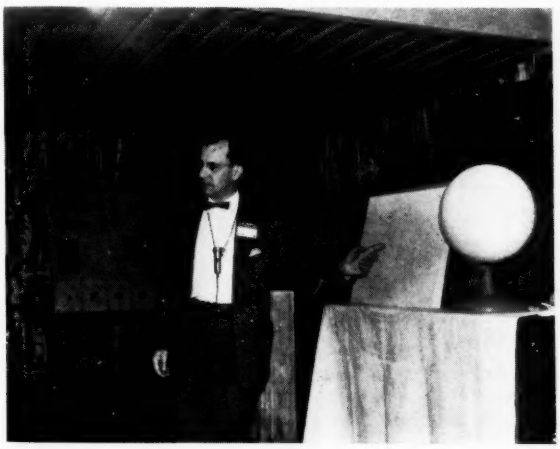
The Martian longitudes on the central meridian in the six globe photographs, including a key central feature in each, are approximately as follows (left to right): (1) 50° — Aurorae Sinus (2) 110° — Solis Lacus (3) 155° — Mare Sirenum (4) 190° — Elysium (5) 245° — Maria Cimmerium-Tyrrhenum (6) 300° — Syrtis Major. North polar cap (at bottom right) is prominent, as observations were made during Martian winter. Photos courtesy of Dr. de Vaucouleurs.

rotation of Mars. This correction will increase in the future.

When all these corrections are applied we find that the agreement of the measured longitudes of well-defined points on Mars, such as the Juventae Fons, is much improved; the scatter between independent determinations decreases from several degrees to little more than one degree. A preliminary reduction of part of the data gives for the coordinates of this spot: longitude 61°.88 with a probable error of 0.11 degree, latitude –4°.75 with a probable error of 0.25 degree. However, our study of the systematic errors in latitude is still in progress and we cannot yet presume what the final value will be.

Nevertheless, it is already clear that, by paying careful attention to the many small systematic effects previously neglected and reducing the various data to a homogeneous system, it will be possible to derive a set of areographic coordinates systematically accurate to a few tenths of a degree (i.e. 10 to 20 miles), at least for the well-defined points of the Martian surface.

This is the first of a series of articles by Dr. Gerard de Vaucouleurs which will appear regularly in THE REVIEW OF POPULAR ASTRONOMY. *See article at right for further information on the author.*



Dr. de Vaucouleurs delivering Astronomical Society of Pacific Morrison Lecture at recent convention of Western Amateur Astronomers in Long Beach, Calif.

NOTES ON THE AUTHOR

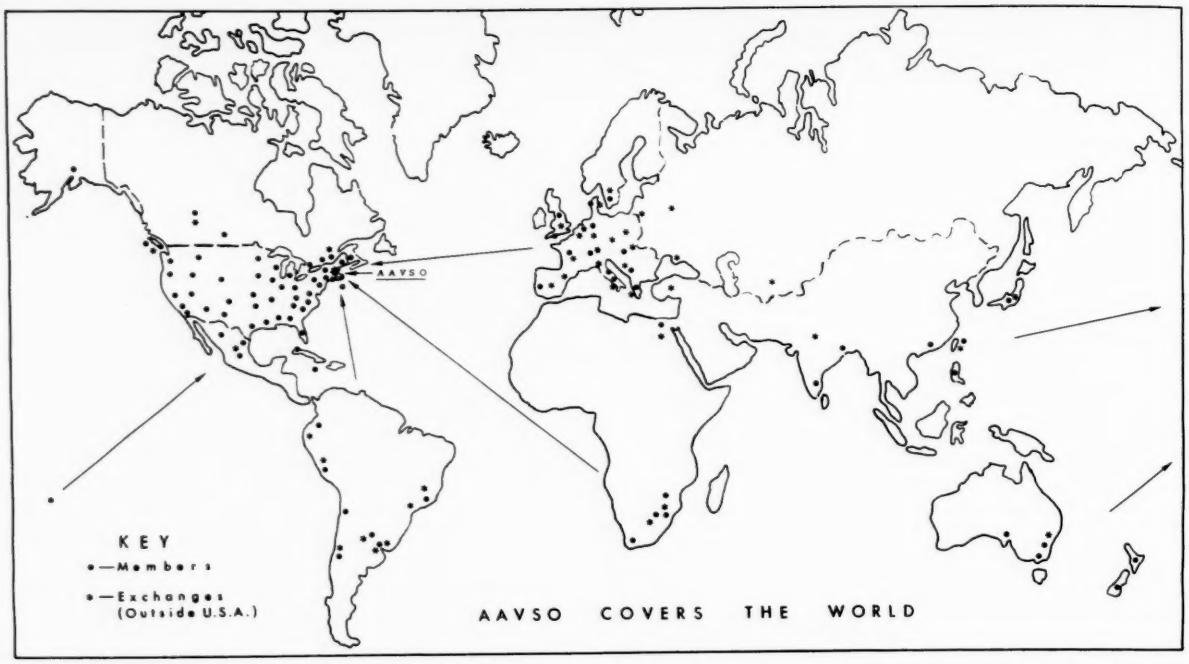
IT IS DIFFICULT to cover the many facets of Dr. Gerard de Vaucouleurs and his work in a few paragraphs. Well known to amateur astronomers through his lectures, articles and recent books—*Physics of the Planet Mars, The Planet Mars, Discovery of the Universe,* and the new Larousse *Encyclopedia of Astronomy* (co-author)—Dr. de Vaucouleurs is currently teaching at the University of Texas and pursuing research at the McDonald Observatory. Although he is a native of France, he has quickly become an adopted Texan, complete with wide-brimmed Stetson which he wears with a jaunty flair.

After leaving France in 1951, he did research on southern galaxies at the Commonwealth Observatory and at the Yale-Columbia southern station, both in Canberra, Australia. In 1957-58 he was associated with the Lowell Observatory, in 1958-60 with the Harvard College Observatory, after which he came to the McDonald Observatory and the University of Texas.

Perhaps best known for his work in galactic and planetary astronomy, Dr. de Vaucouleurs also numbers among his more than 100 technical articles extensive research in such fields as astronomical photography, eclipses, double stars, variable stars and stellar photometry.

He has delivered radio talks for BBC in England and for the Australian ABC, and is presently a consultant for such institutions and firms as the Geophysics Corporation of America, Harvard College Observatory, Convair, Cal Tech's Jet Propulsion Laboratories, and the RAND Corporation.

Dr. de Vaucouleurs is also a highly experienced visual observer and a former amateur astronomer. THE REVIEW OF POPULAR ATRONOMY is certain that his continuing series of articles will be read with special interest by all amateurs.



The stars literally never set on an AAVSO member, as this world map of AAVSO membership indicates. In many cases, of course, one black dot indicates a number of observers, especially in the U. S. and Canada. Exchanges of reports, maps and other data are also made with institutions and variable star groups throughout the world. (AAVSO Map)

PART TWO

THE STORY OF THE AAVSO

By R. Newton Mayall

[Editor's Note: *We are proud to publish the second and final part of this history of the American Association of Variable Star Observers on the occasion of that organization's 50th anniversary. In the first part, published in the Sept.-Oct. issue, Mr. Mayall covered the beginnings of the AAVSO, its development into an unique, world-wide organization based at Harvard Observatory, and its eventual separation from Harvard as the result of a reorganization at the Observatory in 1952. The dilemma that followed, the international "vote of confidence" by professional astronomers, and the ensuing development of the AAVSO into a wholly independent and expanding organization of many facets is the subject of this concluding section.*]

The summer of 1952 was one of many decisions for the American Association of Variable Star Observers. The loss of its original headquarters and endowment income demanded immediate but thoughtful action. Legal counsel retained by the AAVSO reminded the officers that the Association was organized as an independent and non-profit corporation, but suggested a revised constitution which would serve the AAVSO in its future function as an independent research organization. Endowment fund and finance committees were established, and the title of "Recorder" was changed to "Director." The decision was made not to attach the AAVSO to another educational institution; but, at the end of the one-year grace period the organization would have to move from Building "A" and relinquish the income from all but the original $7,000 fund. The financial reorganization required to maintain and expand previous work was, in itself, a major task, and called for sober and realistic consideration on the part of the officers.

So, before the final decisions were made, the value of the work of AAVSO in the past, and possible future value, was assessed. The Director wrote to astronomers throughout the world, explaining the situation and asking for their frank evaluation of the AAVSO and possible future growth. Typical of the hundreds of replies was that from Dr. Otto Struve, written November 21, 1952, when he was president of the IAU:

"I feel very strongly that the AAVSO has rendered an enormous service to astronomy during the past thirty years and our knowledge of variable stars would be infinitely smaller if it had not been for the earnest work of the amateur astronomers who participated in your organization. I myself have regularly consulted the data published in Popular Astronomy and other media used by the Association. Among the most useful enterprises of the AAVSO has been the issuance of star fields for variables, and astronomers all over the world have made use of these blueprint charts. I myself have used them extensively at McDonald Observatory. I believe that amateurs in other countries have been largely inspired by the success of AAVSO to form similar groups, such as the ones in France, Denmark, and elsewhere."

With this and similar assurance from the astronomers of the world, AAVSO made the decision to stand

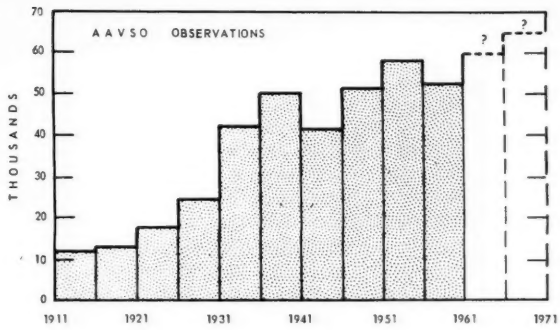
on its own two feet. In January, 1954, the office was opened in a well-managed building at 4 Brattle Street, Cambridge, in Harvard Square. It was only a few steps from Harvard Yard and about ¾ of a mile from Harvard Observatory. This was ideal, for it placed the AAVSO near the center of research and the Observatory. The ties of over 40 years are not easily broken. Dr. Menzel invited the AAVSO to continue to use the research facilities at the Observatory and lent a helping hand in other ways.

Friends, members, and the scientific community stood by the organization. Major financial support came from the Office of Naval Research, National Science Foundation, Bureau of Standards, National Academy of Sciences, the Astronomical Society of the Pacific, and from some private sources that desired anonymity. Industry also made contributions to the endowment fund. Some of the AAVSO's material and publications are used by industry—by those involved in artificial satellites, communications, and numerous other fields.

About the time of these difficulties, the demise of POPULAR ASTRONOMY was announced. This magazine had been in continuous publication for over 50 years, and had regularly published AAVSO observations and notes on variables. A medium to publish material is as necessary as financial aid. The Royal Astronomical Society of Canada came to the fore and offered the pages of its *Journal*, thereby providing continuity for published observations and notes. This solved a major problem. Also *Sky and Telescope*, through Charles Federer, published other data that are useful on a monthly basis, such as predictions of variable star maxima and the American sunspot numbers from the AAVSO solar division.

The move to new headquarters in 1954 marked the beginning of a nova-like rise into a new era of service for the AAVSO. It began to expand its programs and add new ones as soon as possible and as funds would allow. Its independent status as a basic research organization became firmly established. It is recognized among scientists throughout the world, who through their actions support and cooperate with it. In this and many other ways they have shown their respect not only for the organization and its achievements, but also for those who comprise it.

Chart at right shows numbers (in thousands) of observations reported to AAVSO in five-year periods since its beginning in 1911. Fluctuations in recent years suggest general periods of good and bad weather conditions. (Courtesy AAVSO)



TODAY, THE AAVSO celebrates 50 years of continuous service to astronomy. As the new era dawns it is time to reflect a bit and look at what it has done. From the standpoint of number of observations contributed it has no peer; but that is only one of the facets of this unique organization. Little did those seven men in 1911 know that they had formed the nucleus of what was to become the largest organized effort in the world devoted to the study of variable stars. The AAVSO is a living memorial to its founders, and to its members both past and present, for without their devotion it could not have attained its present status.

From that handful of observers in 1911 has grown an association of more than 800 members scattered throughout the world. This widespread distribution of observers makes possible continuous coverage of both northern and southern hemispheres. As compared to the few variables under observation in 1911, nearly 1,000 receive attention today, and new stars are frequently added to the list.

The progress of observations through the years has been remarkable. The average number of observations contributed in the first five-year period (1911-1916) was 12,000 per year. Today observations are being received at the rate of about 5,000 per month, or 60,000 per year. The one-millionth observation was made on March 3, 1946, by the late Dr. William L. Holt, a retired physician in Scarboro, Maine. The star observed was Chi Ceti. Observation 1,500,000 was made on June 10, 1953 by Curtis Anderson, who is engaged in industrial research in Minneapolis, Minnesota. The star observed was DQ Herculis. Today observers are nearing the 2,000,000 mark! Members use everything from binoculars to a 100-inch (!) telescope. This growth of observers and number of observations has made possible the plotting of 40- to 50-year light curves of about 500 variables!

Prof. Ernest W. Brown of Yale, in a paper published in *Variable Comments*, April, 1927, suggested observations of occultations as a new field of activity for the AAVSO. He outlined the problem, method of observing, and reduction methods. The AAVSO had never yet let the suggestion of a professional fall on deaf ears, and it was not long before a small group, under Dr. Brown's guidance, began observing occultations. Today many members, under the chairmanship of Roy Seely of New York City, are observing occultations and their reports form a major part of the observations sent to the international headquarters at Herstmonceux in England.

At an early date a solar section was set up. Most of the work was done by Mrs. Kearons and Messrs. Heines and Kirkpatrick. Their observations were sent to the Sunspot Bureau in Berne, Switzerland. The AAVSO now has a large and active Solar Division, with Harry L. Bondy of New York City as chairman. The American Sunspot Numbers are derived from the reports of this group and then are sent to the U. S. National Bureau of Standards for their use. The Bureau of Standards helps support the program, and also supports the solar section's work on SEA (sudden enhancement of atmospherics). During the war years the Solar Division, under Neil Heines, supplied sunspot information that was of value in communication problems, as it gave warning of lapses due to sunspot activity.

Dr. Paul W. Merrill of Mt. Wilson and Palomar has had a close association with AAVSO for more than 40 years. In a letter to the Director dated November 24, 1952, he stated: "My spectroscopic studies have bene-

fitted greatly by information supplied by yourself and previously by Leon Campbell." He continues with: "It goes without saying that accuracy should be increased if possible. Should not the AAVSO take an interest in helping the more serious and capable amateurs to adopt photoelectric observations?" Merrill was not aware, at that time, that John Ruiz in Dannemora, New York, was actively engaged in such a program. Ruiz has been a pioneer among amateurs in this field. It was not long before Lewis Boss in California, Claude Carpenter in California, and Clinton Ford in Connecticut became interested in the program. A photoelectric photometer (PEP) committee was set up to organize a program, under the chairmanship of Boss, and provide assistance to others wishing to observe by this method. Boss took over the editing of a handbook for the construction and use of the necessary equipment. Lately Donald Engelkemeir in Illinois has joined the committee. The work of this group has been outstanding and is concerned chiefly with observations of eclipsing variables and flare stars.

Education always has been an active part of the AAVSO program. Its excellent library was founded by Charles Y. McAteer and bears his name. Subsequent contributions have increased its size until today it is an up-to-date reference library containing several thousand volumes and publications on astronomy and allied scientific fields. A slide collection is maintained from which members may borrow slides for lectures. A great many members are the only source of astronomical information in their communities where they have done much to engender an interest in astronomy. Some have organized classes and taught astronomy to workers in industrial plants. Still others have written books for the layman.

THE AAVSO encourages high school students. Its members vary in age from 16-90; and even youngsters of 12 years contribute good observations while they eagerly await their 16th birthdays when they can become full-fledged members. Another educational service is the free distribution of a "kit" to would-be observers, interested secondary-school students, and to teachers. The Association has about 30 telescopes on loan to deserving observers both in this country and abroad.

Since the beginning, the Association has been a prime mover in the standardizing of observing procedures. Its collection of standard charts of variable star fields is the best and largest in existence. They are used throughout the world by both professional and amateur. About 2,000,000 observations of nearly 1,000 variables are on file at headquarters, making it the largest and most complete collection of such data in the world.

Officers of the AAVSO during its period of readjustment are shown during the annual fall meeting at Harvard in October, 1949. (Left to right) Clinton B. Ford, secretary; Percy Witherell, treasurer; David W. Rosebrugh, retiring president; Leon Campbell, retiring recorder; Margaret W. Mayall, director; Martha Stahr Carpenter, vice president; and Neal J. Heines, new president.

Pickering's system of observing and estimating magnitudes has proved itself over the years. Not only has it made possible the publication of up-to-date reports but, of even greater importance, has enabled the AAVSO to provide astronomers with current information. This system also makes possible the plotting of observations as they are received, thereby providing an up-to-date visual reference to the activity of any star on the list. The AAVSO is the only source in the world from which such up-to-the-minute data can be obtained.

Campbell's research, using the data on file, resulted in one of the AAVSO's most important publications: *Mean Light Curves of Long Period Variables*, which contains mean curves of about 400 stars. It is a valuable document both for observers and professional astronomers.

Novae are also variable stars—exciting ones. In order to encourage the search for novae among observers, the Association, in 1928, established its Nova Award Medal. It may be awarded to anyone anywhere, member or not. The only restriction is that it will be awarded only for "the original discovery of a nova found by visual methods." Since then five persons have received the award. Today an active nova search section operates under the chairmanship of George Diedrich in Ohio.

A flare star program has been initiated. Selected observers have sent in valuable observations on these stars, which require long periods of continuous watching. This is a painstaking and exhausting program, unless done with photoelectric recorders. Members frequently cooperate in this type of work at the request of some professional.

Predictions of maxima and minima of long-period variables are published regularly, the first of each year. This provides information based on up-to-the-minute activities of the variables, and is of great value to the professional astronomer in setting up photographic and spectroscopic programs.

Other publications of the AAVSO are "Variable Star Notes" that appear regularly in the *Journal* of the Royal Astronomical Society of Canada; predictions of maxima for long-period variables brighter than 8th magnitude, and monthly sunspot numbers in *Sky & Telescope; Quarterly Reports* containing a summary of observations received in a specified period are sent to observatories

all over the world: *Abstracts* of papers presented at meetings; *Book Reviews* of books of interest to members; *Manual for Observing Variable Stars*, for the beginner; and a "kit" sent to inquirers for information about AAVSO. Observations are now published in 10-day means. Individual observations are preserved on microfilm and on the original reports. Exchange is maintained with observatories and scientific societies throughout the world, including the USSR.

The most important publication is that of standard charts of star fields. The first charts were made and distributed by Olcott. Since then several members have volunteered to make them. Brocchi, Seely, and now Robert Brady of Georgia are familiar signatures on the charts. Richard W. Hamilton in Connecticut is chairman of the chart committee and curator of charts.

Although its primary objective of correlating observations and making them available to professionals is important, it is not the only service it renders to science. The Association has been the training ground for many of our well-known scientists of today. Some have remained in astronomy, others have sought other branches of science. It is this field that AAVSO takes great pride. No other amateur organization can point to so many that it has guided into scientific endeavors. Here is perhaps one of the AAVSO's most important achievements.

One of the fine things about AAVSO is its flexibility, which might be expressed better as the willingness on the part of its members to add specific observing programs to their schedule. Such a program was the Cornell University National Geographic Society Study of Aurora begun in 1938. The value of the members' contributions to such programs is gratefully expressed in a letter to the Director, from Dr. Carl W. Gartlein who was director of the Study, dated January 12, 1953 as follows:

"In the early days of our project—1938—observers were enlisted from the AAVSO group. They were excellent and some have continued to the present day. So with their help we have a nearly complete record of auroral occurrences in lower latitudes from 1938 to date. I believe this is the largest continuous record of aurorae in the Western Hemisphere. This very day I have received a request for auroral data from the present back as far as possible for use by a reliable organization in weather research. I would not be able to fill this request without the data from AAVSO members and no one else has the data."

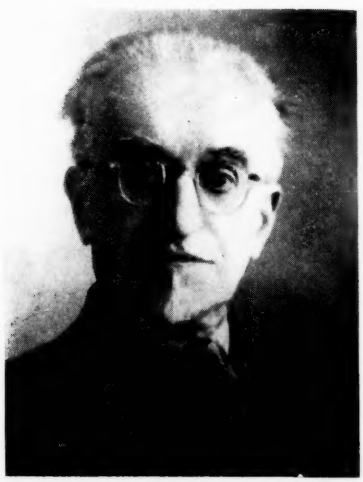
Some of the members are still cooperating with Dr. Gartlein in a continuing study of aurorae. This is but one of many such examples of the flexibility of the organization and its members.

But what about the members themselves? The AAVSO *is* its members. They have been drawn together from all corners of the globe through the common bonds of friendship and one of the most satisfying and fascinating hobbies in the world. No story of the AAVSO is complete without mention of them. We can pick out only a few here—they are typical of the many.

Outstanding in their observational quality and quantity are men such as Peltier of Delphos, Ohio; Fernald of Wilton, Maine; DeKock in South Africa; and Lacchini in Italy. Some have contributed over 100,000 observations and many over 10,000. The list is long.

Peltier's is a most enviable record. He has submitted monthly reports without interruption since March 1,

"The Observatorio Leon Campbell" is the wording inscribed on a plaque at the entrance to this observatory in Puebla, Mexico. Owned by AAVSO observer Senor Domingo Taboada, it is considered to be one of the world's best equipped private observatories. Among other instruments, it houses a beautifully mounted 6-inch refractor and a 10-inch polar telescope, the latter which is shown in this photograph with the cover to its siderostat mirror removed. Observer sits inside building at stationary eyepiece. Observatory was officially dedicated to late AAVSO recorder Leon Campbell by Senor Taboada.



Still an active AAVSO observer at 77, Signor Giovanni Lacchini of Bologna, Italy, made his first AAVSO variable star observation 50 years ago! A message of congratulations from Signor Lacchini was read at the AAVSO 50th anniversary meeting. Photo, taken in 1956, courtesy of AAVSO.

1918. Although we have many ace observers, Peltier might be called a modern Olbers for, in addition to an active business life, he has not only observed variables but has given much time to acquainting others with the way of the stars. He has received many medals and awards for his discovery of new comets and the rediscovery of old ones. For his contributions to the Association and to his community, AAVSO bestowed its first Merit Award. In 1947 he was given an honorary Doctor of Science degree by Bowling Green State University. In 1959 Miami University in Oxford, Ohio, gave him its 12-inch refractor and observatory building, which he moved to Delphos where it contributes to AAVSO and to his community.

Because there are many members like Peltier, young people continually have been brought into the fold. This has kept the membership alive and growing, in both hemispheres. Not the least influential in this field have been the Association's two long-term secretaries—Olcott in the beginning (1911-1936), followed later by Clinton B. Ford (1948 to date). Their voluminous correspondence and ability to travel have made them ambassadors of good will, cementing the bonds of friendship.

Its honor roll of present-day internationally known scientists who joined the AAVSO when they were students, is also long. They were encouraged to pursue successful scientific careers by the Association's early recognition of their abilities. Among them we find Dr. Walter S. Baird (physics); Dr. James G. Baker (optics, astronomy); Dr. Peter Millman (astrophysics); Dr. Donald Menzel (astrophysics); Dr. Willem J. Luyten (astronomy); Dr. Elizabeth Roemer (comets); and Dr. Martha Stahr Carpenter (radio astronomy). These are but a few, picked at random. As time goes on the list will get longer. Today's students are continually using the facilities at headquarters to obtain basic data for research required for their theses, both undergraduates and graduate. The Association cherishes its young members, many of whom have won Westinghouse Scholarships and National Merit Awards.

The AAVSO has provided leaders and observers for Moonwatch groups. Their knowledge of stars and instruments was a valuable asset when the world-wide need for tracking stations became apparent. Where could scientists go for trained observers of the skies? The answer was "to the AAVSO."

What of the future? The Association has justified its existence. The founders can look down with pride. It has proved itself virile, not only as a service organization but also in the matter of its endowment, which has grown to the value of about $150,000—all obtained during the last seven years. However, that is still not enough help. Its goal is to be free of financial worries, with a large enough endowment to take care of its necessary expenses and to continue its educational work. The future looks bright. What better reason to celebrate? The Association is grateful to Dr. Menzel, Director of Harvard Observatory, and a member of AAVSO, for having extended an invitation to hold its 50th anniversary meeting at Harvard this October. What more appropriate place could there have been.

It was also fitting that the 1961 spring meeting was held in Ottawa, Canada, so that our many Canadian members could join in a preliminary celebration.

The final celebration took place in Cambridge on Oct. 12-14, 1961. It is, of course, unfortunate that the majority of the members could not be present. However, they were all there in spirit, for each has the satisfying knowledge that his or her hours at the telescope have not been confined to "just star-gazing." Each has the pride and joy that comes of knowing that what he has done has contributed to the astronomer's knowledge of the universe around us. May the next 50 years show an ever increasing membership and still greater service to science.

This concludes a series of two articles by R. Newton Mayall on the history and development of the American Association of Variable Star Observers. A limited number of reprints of the articles will be available from the AAVSO in the near future.

VARIABLE STAR OBSERVERS CELEBRATE 50TH YEAR

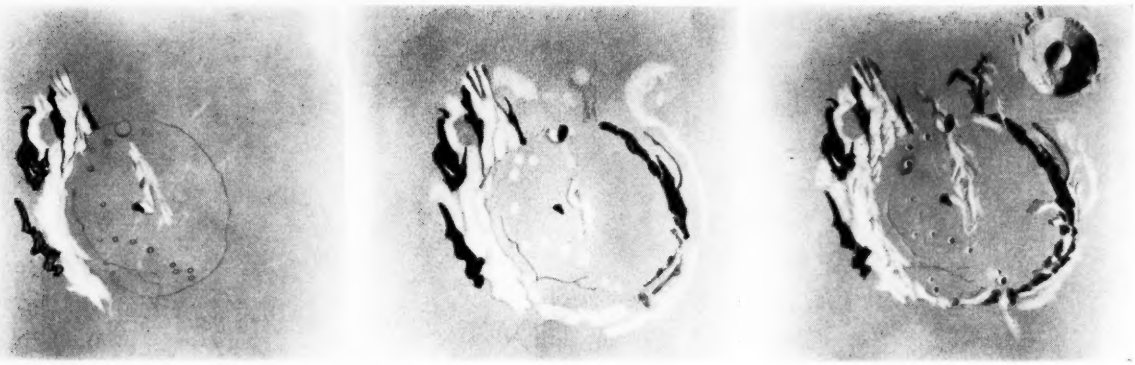
More than 125 members and guests gathered at the Harvard College Observatory on Oct. 12-14, 1961, to mark the 50th year of the American Association of Variable Star Observers. The photograph above was taken before many members arrived.

Among the features of this Cambridge meeting of the organization was a symposium on variable stars by professional authorities, a paper session covering variable star and solar observation, a tour of the new Smithsonian Astrophysical Observatory building, and a formal banquet on the final night.

On Friday evening, Oct. 13, Dr. Harlow Shapley, formerly director of the Harvard College Observatory, surveyed the most important developments in astronomy during the past 50 years, a departure from his annual "highlights of the year" talks usually given at the fall AAVSO meetings.

Dr. Dorrit Hoffleit, director of the Maria Mitchell Observatory at Nantucket, was elected president of the AAVSO for 1961-62. A more complete coverage of the meetings will be included in the next issue of this magazine.

D.D.Z.



The author shows steps in his sketch of the lunar crater Alphonsus.

DRAWING THE MOON

By Raymond Coutchie

The recording of surface detail on the moon, although a fascinating and rewarding pursuit, presents many problems to the average amateur. The minute craterlets, clefts, rills, domes, etc., which are beyond the reach of photographic resolution are quite often easily seen even in a telescope of moderate aperture. Russell W. Porter, in the October, 1930, *Scientific American*, describes a method which, with a little practice, is quite simple.

Choice of paper is important. A drawing paper used for pencil sketching is the best. It should be smooth but not glossy; too much texture makes it impossible to record small features. A good grade of typing paper works very well and could be used to start on. Pencils of grade 2H, 4B, and 6B; two ruby erasers (one of which has been sharpened to a point), and an artist's stump are needed. The latter is made of a soft blotting paper rolled in a tight roll and sharpened on each end, much like a cigar in size and shape. This is used to blend and shade subtle color changes in the surface. All of this material may be obtained at stores which carry artist's materials.

The paper is prepared by sprinkling the surface with a small amount of graphite scraped from the 2B pencil. This is gently rubbed into the paper with a soft cloth or tuft of cotton to give an over-all medium gray tone. The graphite should not be scrubbed in nor should any excess be left on the surface.

At the telescope a small white light is used to illuminate the paper to an intensity which approximates that of the lunar surface as it appears in the telescope. Draw in the outline of the major features lightly with the 2H pencil. Next, the heavy shadow areas are blocked in. The outline of these shadows can be sketched and filled in later. (This is the only portion of the drawing that can be done away from the telescope.)

Sunlit areas are removed with the eraser. With small areas it is easier to remove a slightly larger area than necessary and then fill in the edges and details using the 2H or 4B pencil—depending on how dark the detail appears. Gradually work around the entire perimeter of the crater, filling in and erasing as required. Small details on the floor or walls can be marked during moments of good seeing. The time at the telescope should be limited to one-half hour. Shadows move rapidly across the surface and the appearance of details changes quickly.

Do not attempt too large an area at first. Do not scale the drawing too large; a 4 x 5 inch drawing is adequate. Detail around the rim of most craters is usually quite congested. Do not try to draw it all.

Perspective is also important—remember, most of the moon's surface is seen obliquely. Large craters are not round. The solar altitude determines the length of shadows in proportion to the dept or height of the features being drawn. A hill, ridge, dome—any raised feature will have the sunlit portions and the shadows reversed from a depression. To get the feeling of light and shade, try copying a photograph first.

For a drawing to be of value it should be labeled with the time, date, quality of seeing, as well as the telescope magnification and aperture. The sun's colongitude and libration can be obtained from the *Handbook* of the British Astronomical Association. The amateur should remember that he is attempting *draftsmanship*, and not *artistry*. Accuracy of position and relative dimension should be his watchword.

Progressive stages in drawing lunar formations: (top) crater; (center dome or hillocks; (bottom) cleft.

Left to right, Mrs. A. G. Massevitch, USSR; Mrs. V. A. Ambartsumian, USSR; and Prof. V. A. Ambartsumian, USSR—new president of IAU.

IAU MEETS IN BERKELEY

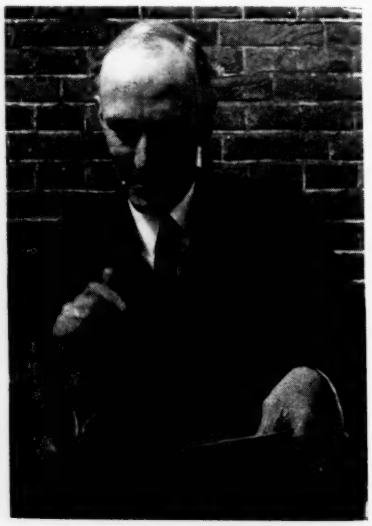
THE ELEVENTH GENERAL ASSEMBLY of the International Astronomical Union met in Berkeley, Calif., from August 14-24, 1961. About 1,000 astronomers from all parts of the world convened at the University of California to discuss mutual problems.

The French astronomer A. Danjon reported on a sudden change in speed of the rotation of the earth which occurred in July, 1959, about the same time as large geomagnetic storms on the sun. The problem of concern is whether the change in speed is real or just a change in normal seasonal variation.

The Commission on Time has recommended the launching of high-altitude (6,000-12,000 miles) satellites, as soon as possible, to test secular drift between gravitational time and atomic time. This experiment has long been proposed by various astronomers as a further test of Einstein's theory of relativity. It was recommended that the use of rhythmis time signals (61 pulses per minute) be abolished. The USSR is the only country still using the rhythmic system. Beginning January 1, 1962, corrective tables will cease publication.

The enormous Jeffers-Vanden Bos *Index Catalogue* of all 45,000 double stars known up to 1961 has been completed. It is too extensive to publish in book form, but by using modern punch card systems, duplicate copies will be filed at astronomical institutions in various countries. The study of double star systems affords the best determination of masses and sizes of stars.

Dr. James Van Allen, discoverer of the belts of charged particles surrounding the earth, stated that the first conclusive evidence of their significant intensities was obtained from geiger counters orbited in Explorers I and III. Apparatus in Sputnik III produced confirming observations.



Dr. J. H. Oort, director, Leiden Observatory, Holland, and outgoing president of IAU.

(Photo: courtesy, J. H. Oort)

The radiation region seems to be divided into two zones, with a gap between them. The inner belt or zone is relatively stable and is believed to result from the action of cosmic rays on the earth. The outer zone varies in size and density as solar activity changes.

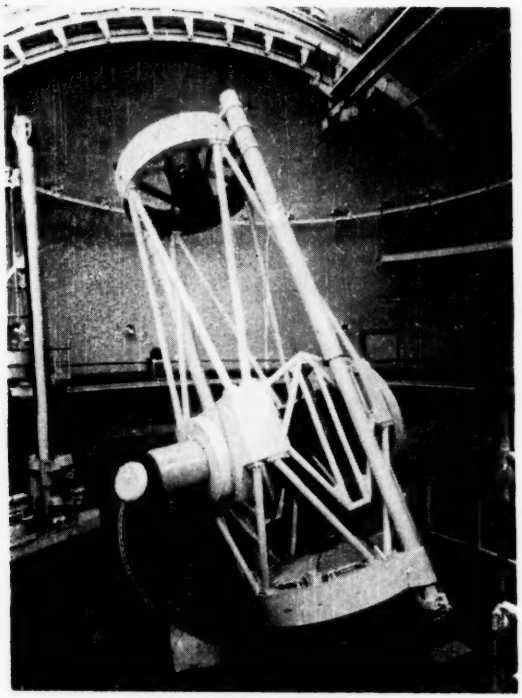
This year Egypt will have a new 74-inch reflector, which will give great impetus to the expansion of scientific and astronomical research in that country. The Helwan Observatory in Egypt has long been an active institution, but larger instrumentation has limited research in recent years.

The observing stations in the Soviet Union are also being enlarged and decentralized. The new 2.6 meter (102-inch) reflector at the Crimean Astrophysical Observatory is the world's third largest telescope. Only the 200-inch at Palomar and the 120-inch at Lick are larger. It is reported that the Russians are working on a 250-inch mirror.

About 40 delegates from the USSR attended this General Assembly. They reported new and improved research facilities in Azerbaydzhan, Lithuania, Kazakh, Latvia, Turkmen, Estonia, and other areas. Many stations are under construction in Siberia, and many more are in the planning stage. Numerous centers will be equipped for radio astronomy and upper-atmosphere research.

Fritz Zwicky of the California Institute of Technology showed a photograph of the most distant supernova ever recorded—with a distance of about a billion light years. Only about 100 supernovae have been discovered in the past 75 years. Supernovae and variable stars are providing vital information as to the workings of our universe. Zwicky will head a new committee of observers from seven nations to coordinate a global watch for supernovae.

Novae are classed among the variable stars—stars whose light changes in intensity. The IAU Commission on Variable Stars has suggested that the American Association of Variable Star Observers take the necessary steps to receive and include in its publications the observations from all other observing groups, thereby making all variable star observations



The new 102-inch reflector in the Crimea, USSR. With this new instrument and photographing in different colors, Prof. Ambartsumian has been able to determine the extent of hitherto unseen arms of distant galaxies. (USSR photo)

more readily available to astronomers.

Academician V. A. Ambartsumian (USSR), newly elected president of the IAU, reported on his recent studies of extra-galactic nebulae based on photographs made with the new 102-inch Crimean telescope. By photographing in various colored lights, he has been able to detect the existence of hitherto unseen arms of distant galaxies.

The Commission on Wave Lengths recommended the agnstrom be defined as 10^{-10} meter; and that the definition in force since 1907, based on the red line of cadmium, be revoked.

Announcement was made at the closing session that Brazil, Turkey, and the Popular Democratic Republic of North Korea were admitted to the IAU. This brings the total to 41 adhering countries.

The new officers of the IAU are: V. A. Ambartsumian (USSR), president; L. Goldberg (USA); Y. Hagihara (Japan), G. Haro (Mexico), R. M. Petrie (Canada), B. Sternberk (Czechoslovakia), and R. H. Stoy (So. Africa), vice-presidents; D. H. Sadler (England) remains general secretary.

R. NEWTON MAYALL

Left to right, Dr. John F. Heard, director, David Dunlap Obs., Ontario; Prof. P. Bourgeois, Belgium; Dr. Otto Struve, Greenbank, W. Va. Photos not otherwise credited courtesy R. N. Mayall.

Did You Know That...

PATRICK V. RIZZO
Amateur Astronomers Association

CAPTAIN COOK, helped by Mason and Dixon and some sauerkraut, was able to make observations of the 1769 Transit of Venus from Tahiti, in spite of the theft and dismantling of his observing instrument by natives who used the parts as ornaments.

As an amateur astronomer, Cook had reported his observations of the eclipse of the sun in 1766 to the Royal Society. Therefore, when the Admiralty suggested that he be put in command of an expedition to observe the transit from Tahiti, the nomination was completely acceptable to the Society.

He set sail in the "Endeavour Bark" with a crew of 81 men and one civilian, Charles Green, a Greenwich Observatory assistant, who had been appointed second observer, Cook being the first. They had as equipment a sextant, barometer, quadrant and two reflecting telescopes. Also on board was a pendulum clock, which had been sent from the colonies by Mason and Dixon, who had used it in their survey of the Pennsylvania boundary. Harrison's new chronometer was in existence but it was not supplied to Cook, since it was still being tested.

Until Cook took command, the story of all exploration had been that after long travel, almost inevitably an outbreak of scurvy would kill many of the crew and bring the voyage to a halt. Cook, by insisting upon a daily ration of antiscorbutic vegetables, particularly sauerkraut, was able to keep scurvy under control and his ship arrived at Tahiti six weeks in advance of the transit.

There he erected Fort Venus, from which the transit would be observed. However, three weeks before the event, some Tahitians purloined the quadrant. After an exciting hunt for the chieftain, suspected of the theft, the English noticed a native openly carrying a part of it. They seized him as hostage and soon all the parts were returned. No further difficulty was encountered. From the observations the longitude of Fort Venus was found to be 8″ of arc.

METEOR FRAGMENTS

TAURIDS, LEONIDS and GEMINIDS ON DECK

by EDWIN E. FRITON,

Regional Director,
American Meteor Society

SOME VERY INTERESTING SHOWERS are in store for this period, but the season also makes it mandatory for the observer to bring his warm "duds" out of storage — twice the clothing warmth as the beginner thinks necessary is needed!

The first show, the Taurids, was mentioned last issue. This is an extended and complex group of showers of perhaps thirty days' duration, which come to a broad maximum between about Nov. 3-10, at which time about 15 meteors per hour may be expected. Actually, recent work by Denning, Whipple, Miss Wright, and others, have shown that there are a number of radiants in both Taurus and Aries which form a diffused but most definitely active series.

Also a part of this great system (it is a much greater one than is generally suspected and is perhaps one of the greatest known, according to A. C. B. Lovell) is the daytime Beta Taurid stream, which is detected by radio-echo methods during June and July. It seems quite likely, because of the work of Whipple (1940 and after) on a number of simultaneously photographed Taurid meteors, that this great assemblage of related streams is associated with Encke's famous short-period comet.

Next on the docket is the annual Leonid shower. In recent years, rates have been generally low, with some exceptions. Dr. Olivier believes that the rates may increase during the next few years, so the shower should be closely watched. It is due to come to maximum on Nov. 16th at about 1 a.m. EST, with a rate of about 15 per hour (Millman, RASC *Handbook*). This shower is well remembered for its exceptionally high rates in the past. Great meteoric storms or very strong showers, occurred in 1799, 1833, 1866, 1867, and 1868, while good rates were noted in 1832, 1898, 1899, 1901, 1903, 1904, 1930, 1931 and 1932. The radiant is near the star Gamma, in the "sickle" of Leo.

Finally, the last shower of note observable this year will be the Geminids, whose maximum is expected at about 8:00 a.m. EST on Dec. 13th, when rates should be about 50 per hour. These meteors are of medium speed, white, bright and leave beautiful trains. The radiant is near Castor in Gemini.

REPORT ON THE AUGUST PERSEIDS

MAXIMUM RATES were obtained by reporting Perseid meteor observers at the McDonald Observatory, elevation 6,800 feet, on Mt. Locke, Tex. Paul Knauth recorded 84 during the hour 2:50 to 3:50 a.m. CST on Aug. 12th. Mike McCants observed 84 between 4:10 and 5:10 a.m., while Dennis Milon saw 83 during this period. The next best rate was observed by Mrs. Lawrence Wolf at Ogden, Iowa, where she recorded 72 during the hour 1:45 to 2:45 a.m. CST on the 12th. A number of others obtained rates between 40 and 70; many had rates of 10-35, depending variously on the time and observing conditions. It has not been attempted to determine the exact time and rate of maximum. This is a result that would best be determined after observations from all over the world have been collected at AMS headquarters. It appears quite clear that the greatest rates were found on the morning of August 12th, which was in line with Dr. Millman's prediction in the RASC *Observer's Handbook* for 1961.

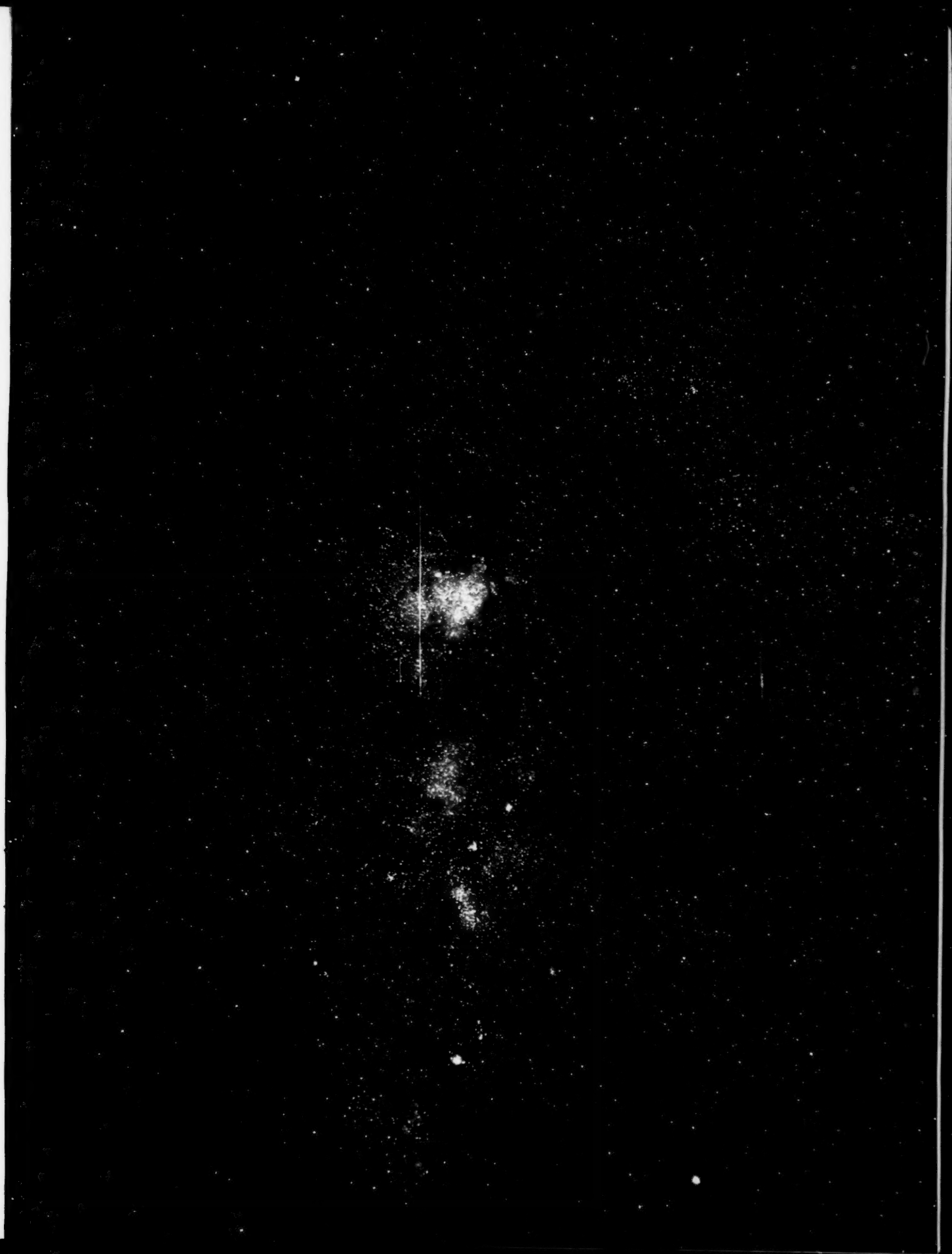
One fact which is again clearly (and painfully) brought out is that observations in or near large cities are of no value for rate determination. The correction factors which would have to be applied are large, variable, and unknown. Nonetheless, any work that has been done under these conditions is appreciated, because of the sincere effort put in; however, it is suggested that those with only fair conditions (at least magnitude 4.5 should still be visible) consider learning plotting of meteors on charts, as this can yield valuable results, if carefully and regularly pursued. Charts, record blanks and instructions are available to serious observers who assure us of their interest and that they have at least a moderate knowledge of the constellations.

It is very much regretted that it is not possible, because of space, to publish these observations in detail here. All useful data are, however, being forwarded to Dr. C. P. Olivier, president of the American Meteor Society, for further analysis and publication in the annual report. The AMS and the staff of THE REVIEW OF POPULAR ASTRONOMY want to take this opportunity to most sincerely thank all who forwarded their observations. Many hours of patient and tiring work went into a number of these reports, most notable of which are Messrs. Scharf and Erickson, who, observing for three nights at Monee, Ill., put in 14.1 and 13.5 hours respectively, with corresponding counts of 398 and 388 meteors. Mr. Scharf takes the blue ribbon for his total, while Dennis Milon, observing at McDonald Observatory, came in a close second with 391, just ahead of Mr. Erickson. [E.E.F.]

PERSEID OBSERVATIONS RECEIVED, 1961

OBSERVER	LOCATION	"NIGHTS"	HOURS	METEORS
Cohen, B. A. & Feldman, D. H.	Baltimore, Md.	Minus 4 fireball 2:24, Aug. 8		1
Conklin, R.	Richmond, Va.	Meteor photo, Aug. 21, about 9:45		1
Dal Porto, D.	Sacramento, Cal.	1	2.0	33
Erickson, D.	Monee, Ill.	3	13.5	388
Friton, E. E.	Creve Coeur, Mo.	2	3.0	36
Fuller, H. K.	Mesa, Ariz.	1	3.2	128
Gardner, B.	Fullerton, Pa.	1	4.5	112
Gibson, J.	N. Belmont, N. C.	1	3.0	65
Hubbard, Wm.	Mt. Locke, Tex.	1	2.0	60
Hunter, J. L.	Austin, Tex.	1	1.0	45
Huston, T. J.	Shelby, O.	3	7.0	41
Knauth, P.	Mt. Locke, Tex.	3	7.0	368
Levine, J. S.	Woodbourne, N. Y.	3	6.5	133
Milon, D.	Mt. Locke, Tex.	3	8.0	391
McCants, M.	Mt. Locke, Tex.	3	7.0	333
Scharf, R.	Monee, Ill.	3	14.1	398
Sloan, M. A.	Escondido, Cal.	1	1.0	30
Sutton, R. M.	Pasadena, Cal.	1	Fireball, plus short session	12 1
Tanzi, J. T.	Roslindale, Mass.	1	1.0	21
Wolf, Mrs. L.	Ogden, Ia.	1	1	72
Zahner, D. D.	Clayton & Pilot Knob, Mo.	2	3.5	102
Zarembka, A.	Gunnison, Colo.	1	1.0	16
Zarembka, E.	Gunnison, Colo.	1	1.0	21
Zarembka, H. J.	Gunnison, Colo.	1	1.0	14
Totals		38	91.4	2,822

Possibly the most striking meteor photograph ever made, this catch of a Perseid meteor was made by Dr. Henry E. Paul (see p. 33) during a long exposure on the Scutum-Sagittarius star clouds. Print covers nearly 50° from top to bottom. Exposure was 1h with 6" efl f/6.3 Metrogon lens working at f/8 (103aE plate).



The 16-inch reflector of Frank Grow was a popular stop for guests at the star party held on the night of the nearly total lunar eclipse. More than three dozen telescopes were on hand for the event.

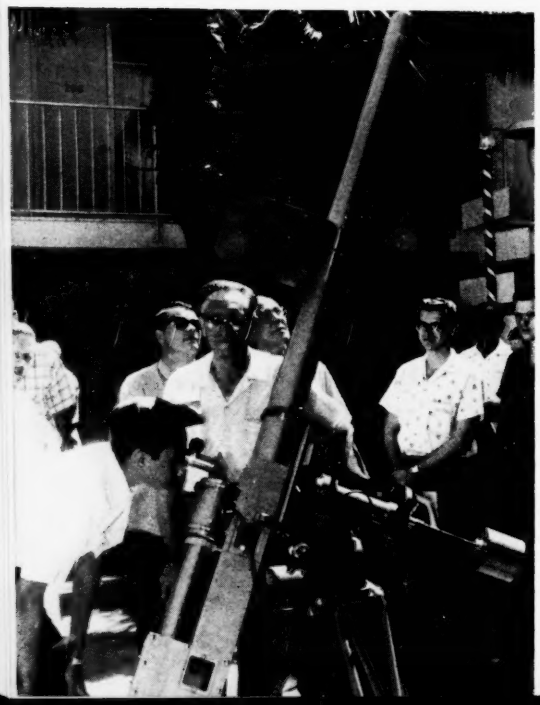
WESTERN AMATEURS CONVENE

FOR 12 YEARS amateurs in the western United States have been banding together in a series of annual meetings that have become major "musts" on the astronomical calendar. In fact, the meetings usually draw a number of visitors from distant parts of the United States. The Western Amateur Astronomers form a comparatively loose-hung organization whose main function is to hold an annual convention, and they perform their assignment well. Attending amateurs can always be assured of a meaty program of lectures, papers and other activities, as well as an opportunity to socialize with other amateur and professional astronomers. The common bond which seems to hold the group together is geographical — the clear skies and usually excellent "seeing" which have made California and neighboring states a Mecca for stargazers.

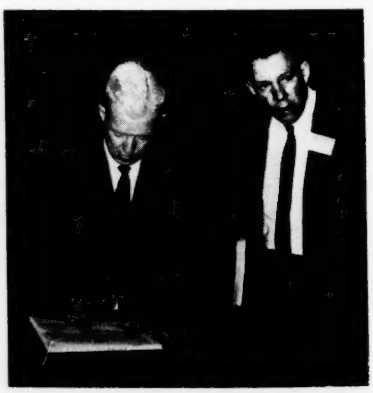
This year's Western Amateur Astronomers convention was no disappointment to the more than 200 registrants. Enhanced by the addition of a West Coast session of the Association of Lunar and Planetary Observers (the other 1961 gathering was held as a part of the Astronomical League convention in Detroit in early July), the August 24-26 session in Long Beach, Calif., offered a varied fare. Three professional astronomers addressed the group in Morrison Lectures during the three days of the regular sessions—Dr. Dinsmore Alter, former director of the Griffith Observatory and Planetarium, spoke with authority on the origin of lunar rays before an interested group on Thursday evening. The following afternoon, Dr. George Abell, formerly of Mt. Palomar and now at the University of California at Los Angeles, presented a lively lecture on the extra-galactic distance scale. Dr. Abell pointed out the great steps man has taken since Aristarchus attempted to measure the distance of the sun from the earth by crude triangulation, and then reminded the listeners of the great refinement of distance scales still necessary for research in the future. He stated that radar investigations under way at the Jet Propulsion Laboratories, at MIT and in Florida should soon produce an astronomical units accurate within one mile, only one of many celestial yardsticks required in sounding the solar system, the galaxy, and extra-galactic space.

On Saturday morning, the sessions were opened with a third Astronomical Society of the Pacific Morrison Lecture, this one by Dr. Gerard de Vaucouleurs of McDonald Observatory and the University of Texas. Dr. de Vaucouleurs' subject was the mapping of Mars, a discussion of his efforts to create a map of Mars accurate within 1° of Martian longitude. Today's maps have errors as great as 10°. (Dr. de Vaucouleurs deals with this subject more extensively in his article on p. 4 of this issue.)

Every offering during the paper sessions was a "highlight," and only space requirements keep us from covering each one in detail. Capt. C. Adair of Santa Barbara showed slides of "A Dozen Famous Telescopes," instruments of special interest both large and small, old and new. For a moment his audience thought that he was going to finish with only 11 famous telescopes, but he reminded them that they had overlooked the most famous telescope of all—their



Solar telescope with monochromator was exhibited at hotel pool-side during a convention break, allowing delegates to enjoy excellent views of solar prominences. Maker George Carroll stands behind instrument.



Two prominent amateurs, Dr. Clarence Custer (writing) and Dr. Arthur Leonard, are caught in a serious discussion during break in WAA convention proceedings. Custer is known for his planetary work and deep-sky photography; Leonard for his achievements in the field of satellite tracking.

own personal telescope! Variable star observer Claude Carpenter of Romoland, Calif., showed color slides of a recent trip to Australian observatories, including a visit to Mt. Stromlo Observatory and its familiar director, Dr. Bart Bok.

Ernest Lorenz, president of the Long Beach Excelsior Telescope Club, which was host for the convention, talked about the stars in the neighborhood of the sun and then explained the design of his excellent "dark light" box on exhibit in the room. Stars in the solar neighborhood were suspended in their relative positions and were viewed under ultra-violet light to eliminate the threads by which the stellar models were suspended.

O. Richard Norton, associate director of the Morrison Planetarium in San Francisco, delivered two talks on meteorites during the meeting. In the first he discussed his researches at Meteor Crater in Arizona: in the second he covered the structure of meteorites and the work which amateurs have and can do in this field.

Instrument-maker George Carroll showed a selection of time-lapse motion pictures of the sun taken with the monochromator and telescope of the Lockheed Solar Observatory, an instrument similar to that which he exhibited at the convention. Delegates later had an opportunity to observe prominences during a break in the proceedings. Moonwatcher Arthur Leonard discussed the activities of his satellite-tracking station, often resorting to the use of the editorial "we," which amused the many listeners who knew of the exceptional accomplishments of this one-man Moonwatch team. Dr. Leonard has succeeded in recovering several "lost" objects through the study of suspected orbital perturbations.

Orders for telescopes and accessories flew thick and fast during visits to commercial exhibits in between paper sessions. Commercial exhibitors included Wyle Laboratories (Goto), Swift Optical, Vega Instrument, Cave Optical and ANRA Manufacturing Engineers. This opportunity to inspect and discuss telescopes and other items is an important part of such conventions.

Other equally interesting papers during the WAA sessions included an explanation of a simple method for determining sidereal time, by Dr. Clarence Custer: a discussion of eight variable stars, three of them discovered by the paper's author, Mt. Wilson's chief solar observer, Tom Cragg: observations of a recent supernova in a distant Virgo galaxy made by Cragg, Leif Robinson and Jack Eastman (read by the latter): problems of aluminizing and coating optical surfaces, by James Dougherty of Pancro Mirrors, Inc.; and a rambling diatribe on unused telescopes—which also reminded the delegates of the telescopic skills that variable star observing develops—delivered by this writer.

The ninth convention of the ALPO met in session on Saturday morning and was led by Dr. Joel Goodman, an active ALPO observer for many years. He spoke on his recent trip to England, showing slides of some English amateurs with whom he visited, their equipment and observatories and discussed with dry wit the hardships forced on these observers by the severe British climate. Patrick Moore has so many trees in his backyard, Goodman commented, that he had a different telescope for each clearing among the trees rather than move one instrument around the yard.

Philip Glaser, Jupiter recorder of the ALPO, made some comments on unusual activity during the current apparition of Jupiter, especially the prominence of the Great Red Spot and the broadening of the north equatorial belt. He requested that observers send in drawings and transmit reports to him as soon as pos-

Dr. George Abell, UCLA, delivers second Morrison Lecture, on "The Extragalactic Distance Scale." Dr. Abell's fast-paced talk impressed the audience with the many problems confronting astronomers in tightening up our presently "loose" scale of extragalactic distances.

Moderator Arthur Leonard listens to Blair medalist and optical authority Carl Wells answer a query during a "Quiz the Experts" session. Other panelists (seated, left to right) include Alan McClure, Roy K. Ensign, Wells, and telescope maker George Carroll, who is contemplating the question.

Members of the Association of Lunar and Planetary Observers attending the WAA meetings join for an informal portrait. Since this was a submitted photo, we do not have identification of several of the members, but feel that readers will be interested in names of many of these active and prominent amateurs. (Standing, left to right) (?); David Barcroft, secretary and a founder of the ALPO; (?); (?); WAA chairman Tom Cave; J. Russell Smith, Skyview Observatory; Philip Glaser, ALPO Jupiter recorder; William Shawcross, Sky & Telescope staff; (?); Dick Nelson, ANRA; Alan McClure, prominent astro-photographer; (?); (?); and, at far right, Thomas Cragg, Mt. Wilson Observatory. (Front row, kneeling) Jack Eastman, whose camera, at least, is responsible for this photo; Eugene Fair; Dr. Joel Goodman, leader of ALPO session; Charles Giffen; and Leif Robinson. (Mr. Glaser and Mr. Giffen came from Wisconsin for the convention.)

sible after this apparition to his *new* mailing address: 200 Albert St., Waukesha, Wis.

Lunar observers made themselves known. Papers dealing with the moon included those by Leif Robinson, "Aristarchus and other Banded Craters"; W. M. Swinburn, "A Lunar Conversion Table"; Francis J. Manasek, "Lunar Crater Terracing"; P. Hedervari, "Energy Necessary to Produce Lunar Ringed-Mountains"; and "The Forms of Lunar Craters," by Patrick Moore, prominent British amateur and author. The latter two papers were read *in absentia*.

Other ALPO papers included an Venus Section Report, submitted by Venus recorder William K. Hartmann; an imaginative and provoking survey of Venus markings, "The Himalayas of Venus," submitted by Richard Baum; "Some Important Martion Phenomena in 1958," submitted by Tsuneo Saheki, well known Japanese ALPO Martian observer; "Herschel—and Exercise in Geometry," prepared by and read for Dr. James Bartlett, Jr., an old ALPO hand from Baltimore; and a paper by William Shawcross on the methods of least squares in combining observations, which was also read at the Detroit Astronomical League convention in July.

Problems of celestial photography, techniques of correctly adjusting the polar axis of an equatorial mount and the use of a micrometer were among the varied subjects confronting a panel of experts which held forth during the Friday afternoon session. The learned panel, under the whip of Dr. Arthur Leonard, included Alan McClure, Roy K. Ensign, George Carroll and Blair medalist Carl Wells. The "Polariscope," a small auxiliary finder with special reticles, which is lined up permanently with the polar axis (or directly within it), was recommended by the panel, as well as photographic determinations as outlined in King's *Manual of Celestial Photography*. Alan McClure pointed out the value and simplicity of the ring micrometer, which is virtually unknown in this country. (The ring micrometer, however, does not replace a filar micrometer for double-star work, since it is designed for determining positions of more widely separated stars and objects, such as a comet against the star background.) As usual, this panel proved popular with the WAA audience, if not with the harried panelists.

A star party was held at a nearby Long Beach city park, but the nearly totally eclipsed moon held observers' interests in the earlier part of the evening. More than three dozen instruments were set up for the event, including two 16-inch reflectors and a "skeleton" from Tom Cragg's closet, his open-tubed "plumber's nightmare." Of special interest during the observing session were Robert T. Jones' Vega Maksutov telescope, Frank Grow's fine 16-inch reflector and the exceptional performance on Jupiter and Saturn of Dick Nelson's 10-inch ANRA reflector during the fine seeing conditions which developed later in the evening.

The 1961 WAA convention was officially concluded on Saturday evening with a banquet at the Lafayette Hotel, which was headquarters for the sessions. Western Amateur Astronomers chairman Tom Cave introduced amateur astronomer and noted motion picture character actor Emory Parnell, who acted as toastmaster. Cave later presented the G. Bruce Blair award for distinguished service to amateur astronomy to Carl Wells. In accepting the Blair medal, Mr. Wells reminisced on the life of Prof. Blair, in the memory of whose name the medal is offered, and his efforts to organize the Western Amateur Astronomers. Mr. Wells' contributions have spanned many decades of work in building telescopes and instructing amateurs in the art.

Alan McClure was presented the ALPO award by Dr. Joel Goodman for his cometary photography, and specifically his work in recovering Comet Borrelly several years ago. Dr. Robert S. Richardson, astronomer, writer and associate director of the Griffith Observatory, gave a humorous talk on the vicissitudes of becoming a professional astronomer, as well as its benefits.

The WAA board announced that an invitation to hold the 1962 meeting in Hawaii had been accepted, and that a cable had been sent to inform Dr. Earle G. Linsley, director of the Bishop Museum observatory and planetarium, of this news and, additionally, of the fact that he had been unanimously elected the new chairman of the Western Amateur Astronomers.

Chairman Tom Cave, the convention committee, including Ernest Lorenz, Bernard Hammer, Mel Mattax, Bert Sproul, Al Jones and Charles Kurtz, as well as the assistance of the Los Angeles Astronomical Society under president James Benson, deserve great credit for a productive, entertaining and smoothly functioning meeting.

D.D.Z.

NOVEMBER and DECEMBER AMONG THE PLANETS

As happens occasionally, the bright planets sometimes become situated so that they are all in the same general part of the sky. This can only happen when they are near superior conjunction with the sun. Mercury reaches superior conjunction on Dec. 16th; Venus approaches close to that position on Dec. 31st and will reach it early in January; on Dec. 14th Mars comes into conjunction with the sun; Jupiter and Saturn will both be in conjunction with the sun in January. All five of the naked-eye planets will be on the same side of the sun and within 38° along the ecliptic at the end of December. The sun itself will be among them with Venus farthest west at 6° from the sun and Jupiter farthest east of the sun at 32°. Reference to the heliocentric planet charts (elsewhere in this issue) should make these configurations clear to the reader.

Sun: In western Libra on Nov. 1st, the sun will move across that constellation and northern Scorpius into southern Ophiuchus by Dec. 1st. At the end of the year it will have reached central Sagittarius. The winter solstice comes on December 21st at 8:00 p.m. (E.S.T.), the sun being then at its greatest declination south. The days in the northern hemisphere begin to lengthen, but a curious circumstance occurs: the time of sunrise continues to come later each day, but the sunset time more than compensates for it. For example, at latitude 40° north, sunrise on the 21st of December is at 7:18 a.m. and sunset at 4:38 p.m. On Dec. 31st sunrise occurs 4 minutes later (7:22) a.m.) while sunset comes 6 minutes later (4:44 p.m.), making a net increase in the length of the day of 2 minutes.

Mercury: Mercury will be in western elongation (19°) on Nov. 7th, and will be visible as a "morning star" for a few days before and after that date. Superior conjunction will occur on Dec. 16th, after which Mercury theoretically becomes an "evening star" (but is too close to the sun to observe). Being near aphelion at conjunction, Mercury will reach almost its greatest possible distance from the earth—1.449 A.U., or slightly more than 134 millions of miles.

Venus: At only 21° west of the sun on Nov. 1st, Venus will be difficult to see, although it appears as a −3.4 magnitude star. Its apparent distance from the sun will decrease to only 6° by Dec. 31st, precluding any opportunities for observation. The descending node will be passed on Dec. 26th.

Mars: Lost in the solar rays 13° east of the sun on Nov. 1st, the red planet will be approaching conjunction which occurs on Dec. 14th. Thereafter Mars becomes a "morning star" but too close to the sun for observation.

Jupiter: Situated in western Capricornus. Jupiter will continue to be observable in the early evening until the end of the year. Its stellar magnitude will change from −1.8 to −1.5 during the two month period.

Saturn: The ringed planet will be near the Sagittarius - Capricornus boundary throughout the months of November and December, where it will be seen as a star of 1.8 magnitude. The sun, approaching this part of the sky, will be within 20° of Saturn by the end of December. During the late part of December, Saturn will cease to be an object of much interest.

Uranus: This 6th magnitude planet will be found about 1¼° east of Regulus. It will be moving very slowly eastward until Dec. 6th, when it will begin retrograding and closely retracing its path. Uranus should be found easily with binoculars as there is no star as bright as 6th magnitude between the planet and Regulus.

Neptune: In western Libra about 3° northwest of Alpha Librae on Nov. 1st, Neptune will be invisible in the bright sunlight until about Dec. 1st, when a telescope will show it as a 7.7 magnitude star just about dawn. On Dec. 31st (New Year's Eve) it will be about 2° north and 1° west of Alpha Librae.

Stuart L. O'Byrne

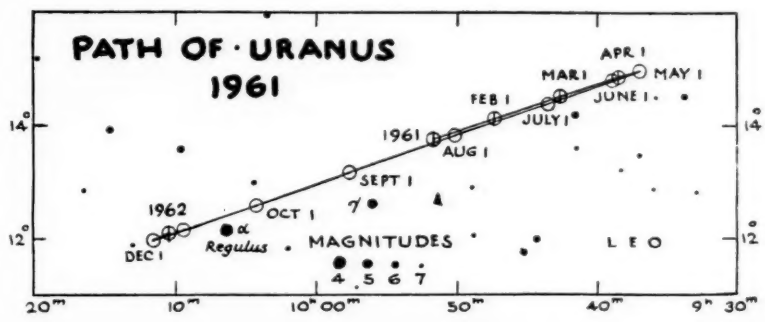
SKYWATCHER'S DIARY

NOVEMBER

Date	Hour (EST)	Event
1	21	Moon at apogee
3	12	Neptune in conjunction with sun
4	12	Venus 4° N. of Spica
6	11	Venus 3° S. of moon
6	13	Mercury 2° S. of moon
7	10	Mercury greatest elong. W. (19°)
8	05	New moon
12	05	Ceres at opposition
13	08	Saturn 3° S. of moon
13	19	Jupiter 3° S. of moon
15	07	First quarter
17	00	Moon at perigee
18	21	Vesta at opposition
20	11	Venus 0°.5 S. of Neptune
22	05	Full moon
22	22	Aldebaran 0°.7 S. of moon
29	08	Regulus 0°.3 S. of moon
29	10	Uranus 0°.1 S. of moon
30	01	Last quarter

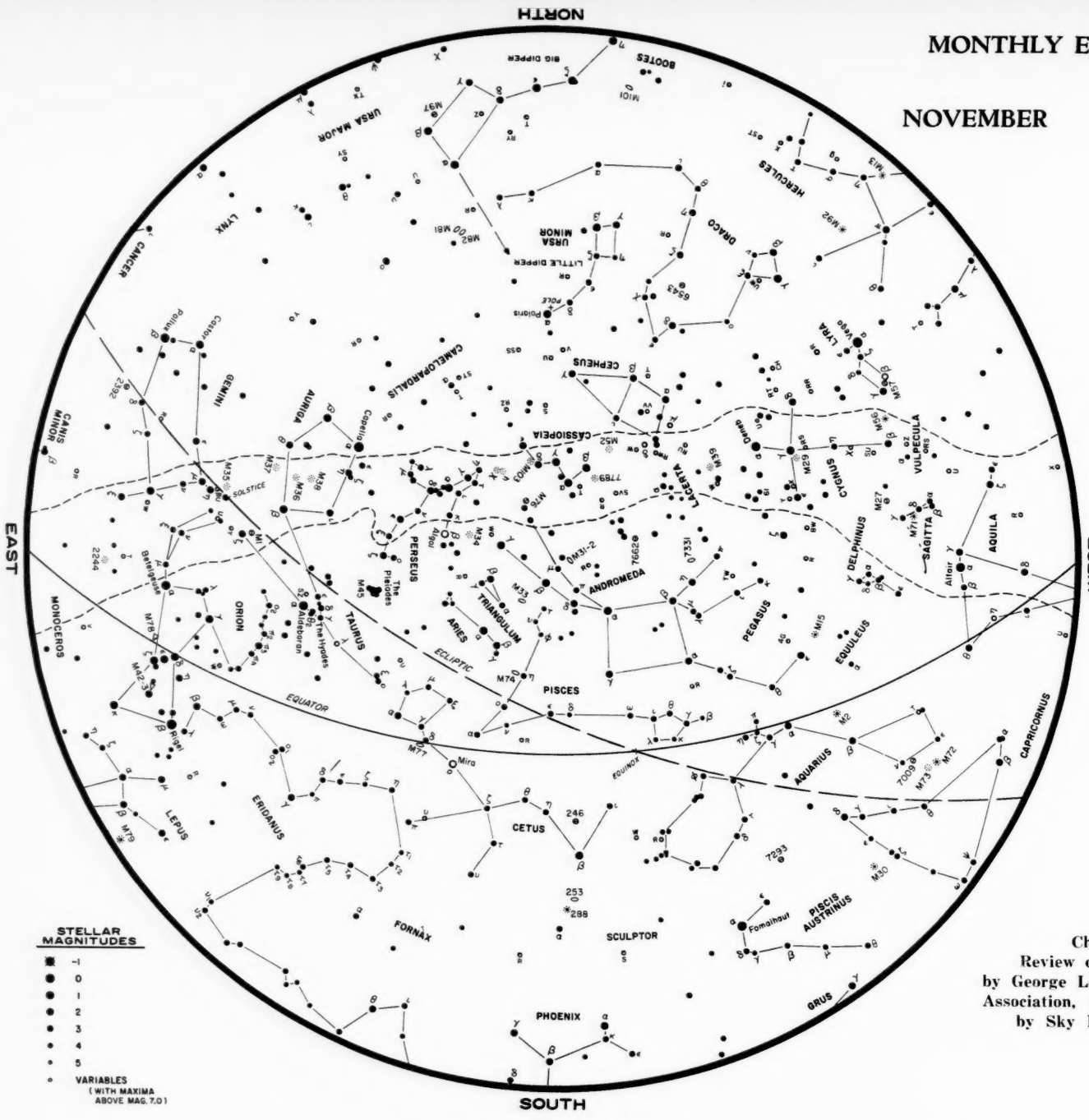
DECEMBER

Date	Hour (EST)	Event
5	05	Neptune 3° S. of moon
6	07	Uranus stationary
6	18	Venus 4° S. of moon
7	19	New moon
10	19	Saturn 2° S. of moon
11	09	Jupiter 2° S. of moon
11	15	Venus 5° N. of Antares
11	19	Moon at perigee
13	08	Geminid meteor maximum
14	13	Mars in conjunction with sun
14	15	First quarter
16	03	Mercury in superior conjunction
18	17	Pluto stationary
20	05	Aldebaran 0°.7 S. of moon
21	20	Full moon
21	21	Winter solstice
26	16	Regulus 0°.5 S. of moon
26	18	Uranus 0°.3 S. of moon
27	14	Moon at apogee
29	23	Last quarter



The tail end of the path of Uranus in 1961 is shown on this chart from the RASC "Handbook" for 1961. Uranus retrogrades Dec. 6th, begins its westward motion among stars.

NOVEMBER



SKY MAP FOR NOVEMBER
Nov. 1, 10:30 p.m. Nov. 15, 9:30 p.m. Nov. 30, 8:30 p.m.
(Local Standard Time)

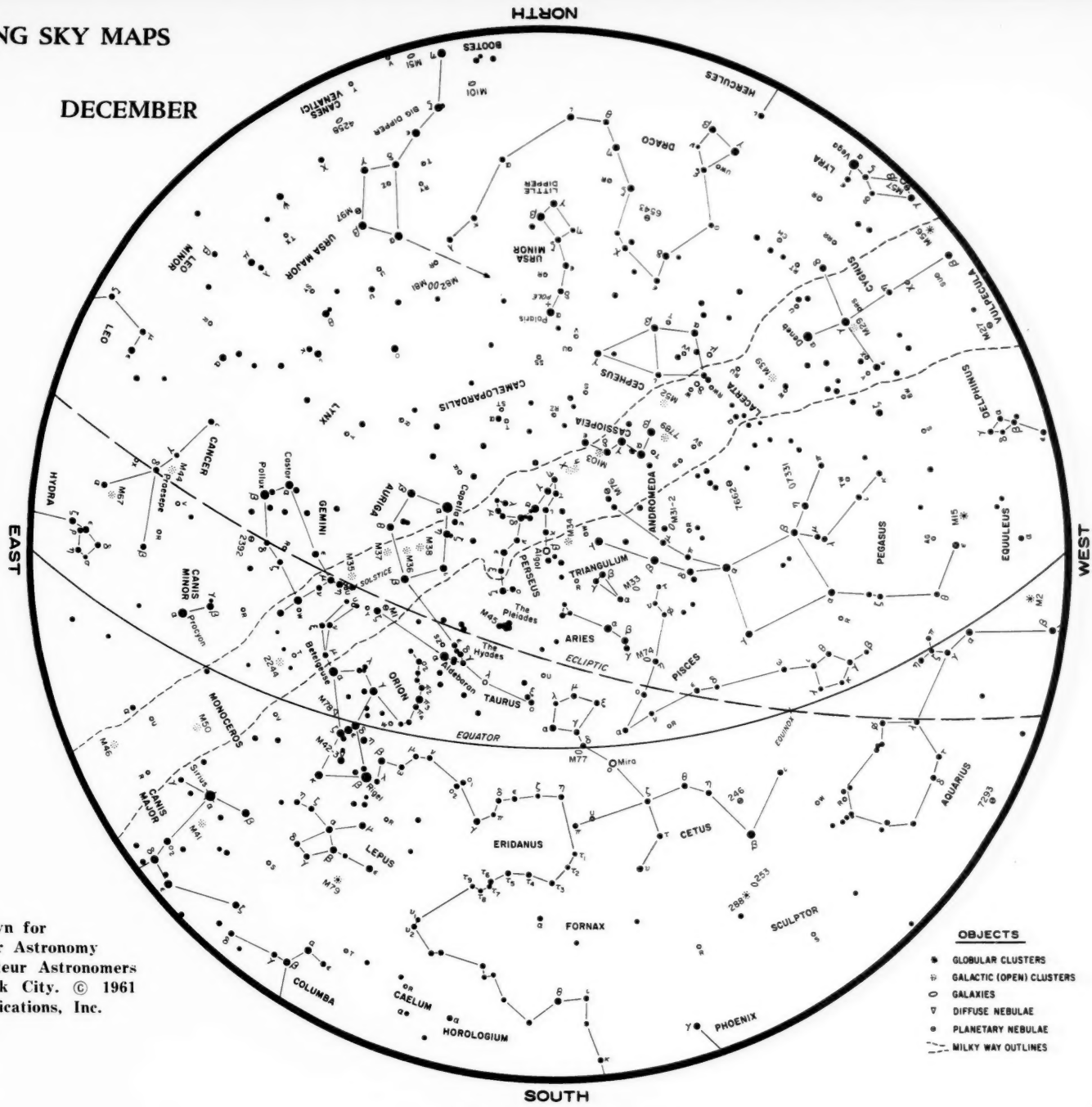
Charts drawn
Review of Popular A
by George Lovi, Amateu
Association, New York
by Sky Map Publica

USE OF THESE CHARTS

These charts, drawn on a stereographic projection to minimize distortion of the constellation figures, are designed for use within about 10° north or south of latitude 40° N. For proper orientation of the chart, hold it over your head and turn the star chart so that the appropriate compass point is directed toward the area of the sky you are observing: i.e., north on the chart toward the north point of your horizon (by turning the chart around 180°). The stars, owing to the earth's rotation, appear to move from east to west during the night at a rate of about 15° per hour (1° every 4 minutes). Also, because of the earth's revolution about the sun, any one star will be 1° further west at the same time from night to night; likewise, the same star will rise 4 minutes earlier (1° of arc equals 4 minutes of time) on each ensuing night. In a month this westward motion amounts to about 30°; in a year to 360°. These charts are designed for use on the dates and at the times indicated, using your local standard time. If used a week earlier than the date indicated, add a half hour to the indicated time of that date; for a week later, subtract a half hour. For different hours than the date-time of the chart, the chart should be turned a bit to match the position of the constellations at that time.

EVENING SKY MAPS

DECEMBER



arts drawn for
of Popular Astronomy
ovi, Amateur Astronomers
New York City. © 1961
Map Publications, Inc.

SKY MAP FOR DECEMBER
Dec. 1, 10:30 p.m. Dec. 15, 9:30 p.m. Dec. 31, 8:30 p.m.
(Local Standard Time)

First-magnitude stars are indicated by name; others are identified by their Greek letter designation. Their approximate brightness can be obtained by referring to the magnitude scale. The outlines of the Milky Way are shown by short dotted lines. All stars to magnitude 4.49 are shown (plus a few fainter stars), as well as all variable stars with maxima brighter than 7.0. All clusters, nebulae and galaxies in the Messier catalog, and the more conspicuous objects from the New General Catalog (NGC) are also included. A legend of objects is listed for convenience in identifying the type of object plotted on the charts.

SKIES FOR NOVEMBER AND DECEMBER

The richest star fields of the celestial sphere wheel into prominence during the next two months. The arrival of Cassiopeia and Perseus at the zenith in the early evening herald the approach of such constellations as Taurus, containing the loose Hyades and Pleiades clusters, Auriga, Gemini, Canis Major with flashing Sirius, and finally, that ultimate assemblage of suns, Orion. The conspicuousness of these constellations makes them easy to identify; once learned, the impression on the mind is even more lasting than that made on the eye.

HOW TO USE THESE OCCULTATION PREDICTIONS

Predictions are made by H. M. Nautical Almanac Office for 12 stations in the United States and Canada. Some of these stations actually lie within certain large cities, but others are merely selected for geographical location and do not coincide with specific cities. Unless you live within a few miles of the points designated by longitude and latitude coordinates of one of these standard stations, correction must be made to the times given in the above list.

First, the longitude and latitude of the nearest standard station must be subtracted from your own longitude and latitude. If you are north of the standard-station latitude or north of the standard-station longitude, the sum will carry a minus sign. The difference in longitude is then multiplied by the longitude correction figure given in the tables for your standard station; likewise for the latitude correction. These two quantities are then added, being careful throughout to take into account the plus and minus signs. The sum of these two numbers will be your corrected factor for that occultation, and is subtracted or added, as the signs demand, from the listed time of occultation. These times are only a guide, however, and you should be prepared to begin observations a few minutes in advance of the predicted time.

Occulted stars are designated in most cases by constellation and appropriate Greek letter designation or Flamsteed number. In some cases the *Bonner Durchmusterung* catalog number (e.g. 57° 485) is used for fainter stars. Only stars brighter than 5.0 are published in this selected list. Complete predictions of all observable occultations are published in advance for each year in the December issue of SKY AND TELESCOPE magazine.

The column under "Phenomenon" shows whether the occultation is a disappearance (D), a reappearance (R), or a grazing occultation (G), which may or may not occur for a particular station. Age of the moon is given in days from new moon, and the position angle on the limb of the moon is given in degrees. Position angle is measured eastward from north; orientation can be determined by letting the moon drift through the field of view to establish the east-west axis. Be certain to allow for inversion by the telescope: in a normal situation, looking generally southward from the zenith, north (0°) will be toward the bottom of the field; south (180°) at the top; east (90°) at the right; and west (270°) at the left.

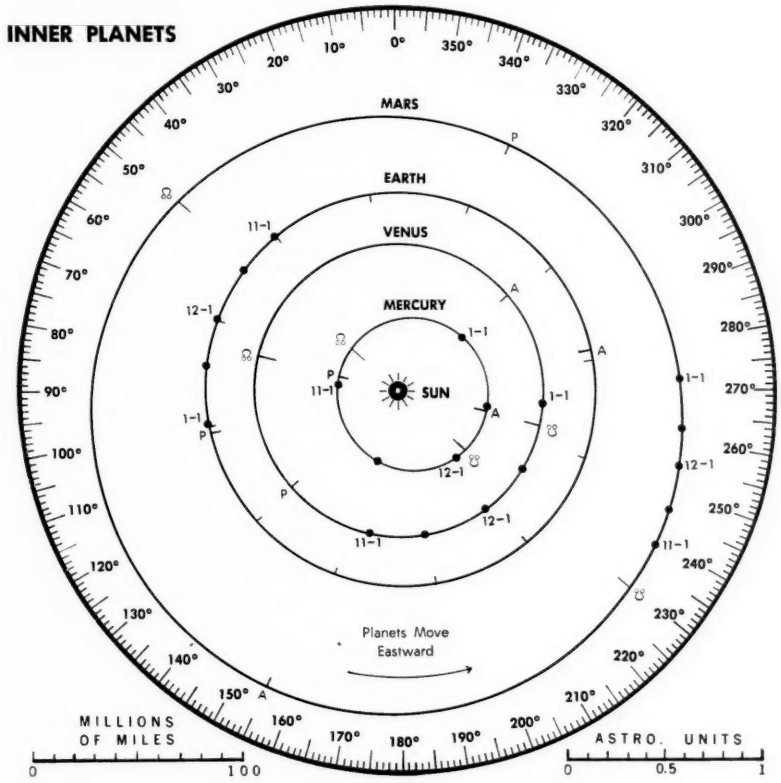
Observations should be sent, as soon after the end of the year as possible, to H. M. Nautical Almanac Office, Royal Greenwich Observatory, Herstmonceux Castle, Hailsham, Sussex, England.

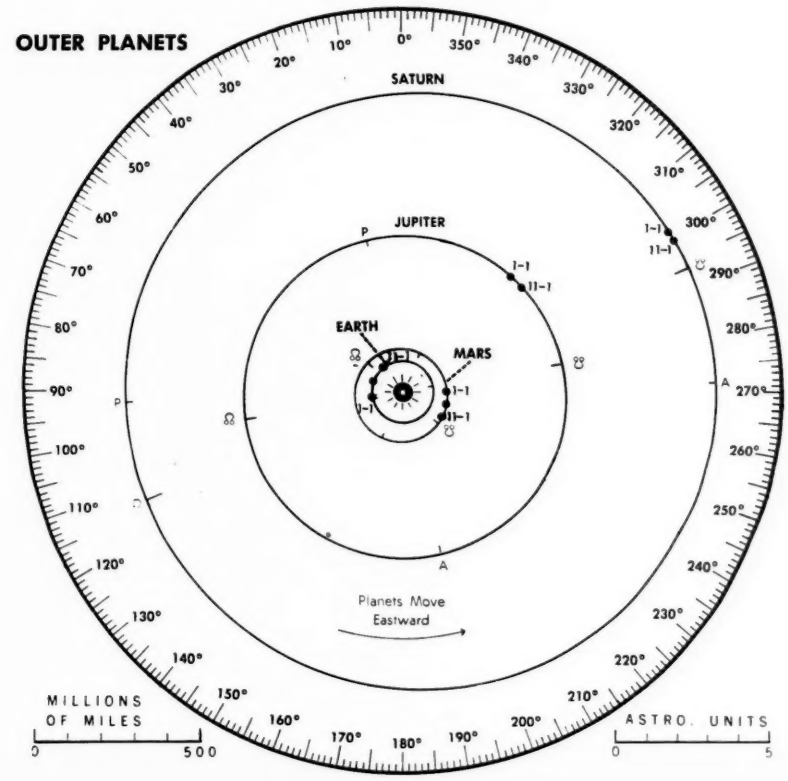
Station & Location	Long.	Lat.
A (Massachusetts)	72°.5	42°.5
B (Montreal)	73°.6	45°.5
C (Washington, D. C.)	77°.1	38°.9
D (Toronto)	79°.4	43°.7
F (Illinois)	91°.0	40°.0
G (Texas)	98°.0	31°.0
H (Denver)	105°.0	39°.7
I (New Mexico-Arizona)	109°.0	34°.0
J (Edmonton, Alta.)	113°.1	53°.5
K (California)	120°.0	36°.0
L (Oregon)	121°.0	32°.5
M (Vancouver, B. C.)	123°.1	49°.5

OCCULTATIONS FOR NOVEMBER-DECEMBER (1961)

Sta.	Date	Name & Number	Mag.	Phen.	Age of Moon	(EST) Time	Correction Long.	Correction Lat.	Position Angle
A	Nov. 3	Chi Leo 1609	4.7	R	25	04:45.6	−1.2	+0.7	285°
	Nov. 20	Mu Ceti 405	4.4	D	13	19:36.2	−1.0	+1.7	66°
	Nov. 22	Alpha Tauri 692	1.1	D	15	19:59.2	−0.7	+1.2	93°
				R	15	21:01.7	−0.7	+2.2	232°
	Nov. 23	119 Tauri 832	4.7	R	16	21:33.7	−1.3	+0.5	292°
B	Nov. 3	Chi Leo 1609	4.7	R	25	04:46.1	−1.1	+0.4	295°
	Nov. 20	Mu Ceti 405	4.4	D	13	19:40.0	−0.9	+1.8	60°
	Nov. 22	Alpha Tauri 692	1.1	D	15	20:02.5	−0.6	+1.4	86°
				R	15	21:07.1	−0.7	+2.0	240°
	Nov. 23	119 Tauri 832	4.7	R	16	22:33.4	−1.4	+0.2	303°
	Dec. 20	264 B. Tauri 677	4.8	D	12	04:20.7	+0.7	−4.3	151°
	Dec. 28	Sigma Leo 1644	4.1	D	21	06:15.5	.....	.....	180°
				R	21	06:53.4	.....	.....	235°
C	Nov. 20	Mu Ceti 405	4.4	D	13	19:25.9	−0.9	+1.6	69°
	Nov. 22	Alpha Tauri 692	1.1	D	15	19:52.0	−0.6	+1.1	96°
				R	15	20:51.1	−0.5	+2.3	228°
	Nov. 23	119 Tauri 832	4.7	R	16	21:26.1	−1.1	+0.7	287°
D	Nov. 3	Chi Leo 1609	4.7	R	25	04:39.2	−0.9	+0.8	287°
	Nov. 20	Mu Ceti 405	4.4	D	13	19:32.5	−0.7	+1.9	57°
	Nov. 22	Alpha Tauri 692	1.1	D	15	19:56.9	−0.4	+1.5	84°
				R	15	20:59.6	−0.6	+1.9	242°
	Nov. 23	119 Tauri 832	4.7	R	16	22:25.4	−1.2	+0.1	305°
F	Nov. 3	Chi Leo 1609	4.7	R	25	04:27.0	−0.5	+1.2	274°
	Nov. 20	Mu Ceti 405	4.4	D	13	19:19.5	−0.3	+1.9	53°
	Nov. 22	Alpha Tauri 692	1.1	D	15	19:49.1	0.0	+1.4	81°
				R	15	20:47.5	−0.3	+1.7	246°
	Nov. 23	119 Tauri 832	4.7	R	16	22:12.8	−0.9	−0.1	311°
	Nov. 29	Alpha Leo 1487	1.3	D	21	07:52.6	.....	.....	48°
				R	21	08:25.4	.....	.....	3°
	Dec. 17	Zeta^2 Ceti 364	4.3	D	10	19:05.3	.....	.....	132°
G	Nov. 20	Mu Ceti 405	4.4	D	13	19:02.0	−0.2	+1.5	66°
	Nov. 22	Alpha Tauri 692	1.1	D	15	19:39.4	+0.1	+0.8	95°
				R	15	20:31.0	+0.1	+1.8	232°
	Nov. 23	119 Tauri 832	4.7	R	16	21:06.7	−0.3	+0.4	291°
	Nov. 29	Alpha Leo 1487	1.3	D	21	07:24.7	−2.8	−0.5	98°
				R	21	08:53.2	−1.4	−2.5	317°
	Dec. 16	Nu Piscis 249	4.7	D	9	23:33.2	−1.0	+2.8	18°
H	Nov. 20	Mu Ceti 405	4.4	D	13	19:16.9	+0.1	+2.0	43°
	Nov. 22	Alpha Tauri 692	1.1	D	15	19:50.6	+0.3	+1.4	71°
				R	15	20:44.8	0.0	+1.4	258°
	Nov. 29	Alpha Leo 1487	1.3	D	21	07:06.9	−2.7	+1.0	77°
				R	21	08:20.0	−1.2	−3.0	332°
	Dec. 17	Zeta^2 Ceti 364	4.3	D	10	18:40.0	−1.1	+0.8	108°
	Dec. 20	Alpha Tauri 692	1.1	D	13	06:45.8	+0.5	−3.0	140°
				R	13	07:18.4	−0.3	+0.8	212°
I	Nov. 22	Alpha Tauri 692	1.1	R	15	20:37.2	+0.2	+1.4	215°
	Nov. 29	Alpha Leo 1487	1.3	D	21	06:54.3	−2.5	−0.2	102°
				R	21	08:27.6	−1.9	−2.0	308°
J	Nov. 20	Mu Ceti 405	4.4	D	13	19:50.6	+0.3	+2.7	9°
	Nov. 22	Alpha Tauri 692	1.1	D	15	20:16.6	+0.4	+1.9	43°
				R	15	22:01.9	−0.1	+1.2	289°
	Dec. 17	Zeta^2 Ceti 364	4.3	D	10	18:53.2	−0.4	+1.7	77°
	Dec. 18	Mu Ceti 405	4.4	D	10	04:33.0	−0.3	−0.9	67°
	Dec. 19	5 Tauri 508	4.3	D	11	00:31.1	.....	.....	140°
	Dec. 19	Gamma Tauri 635	3.9	D	12	22:14.0	−0.8	+1.2	101°
	Dec. 20	264 B. Tauri 677	4.8	D	12	03:40.9	−1.0	−3.9	138°
	Dec. 20	Alpha Tauri 692	1.1	D	13	06:15.8	−0.2	−1.8	99°
				R	13	97:12.7	−0.1	−1.0	248°
K	Nov. 29	Alpha Leo 1487	1.3	D	21	06:29.5	−2.0	+0.2	104°
				R	21	08:01.5	−2.2	−1.2	300°
	Dec. 18	Mu Ceti 405	4.4	D	10	05:02.4	−0.1	−4.1	137°
L	Nov. 22	Alpha Tauri 692	1.1	R	15	20:49.6	+0.2	+1.0	276°
	Nov. 29	Alpha Leo 1487	1.3	D	21	06:33.1	−1.9	+1.5	81°
				R	21	07:49.8	−1.6	−1.9	320°
	Dec. 18	Mu Ceti 405	4.4	D	10	04:44.6	−0.5	−1.9	105°
	Dec. 19	Gamma Tauri 635	3.9	D	12	20:56.4	−0.9	+0.5	118°
	Dec. 20	Alpha Tauri 692	1.1	D	13	06:42.6	+0.3	−4.3	147°
				R	13	07:11.5	−0.9	+1.7	203°
M	Nov. 22	Alpha Tauri 692	1.1	R	15	20:57.1	+0.1	+1.0	290°
	Nov. 29	Alpha Leo 1487	1.3	D	21	06:46.1	.....	.....	51°
				R	21	07:29.7	.....	.....	348°
	Dec. 18	Mu Ceti 405	4.4	D	10	04:32.9	−0.6	+1.3	99°
	Dec. 20	Alpha Tauri 692	1.1	D	13	06:21.1	−0.4	−2.4	118°
				R	13	07:13.0	−0.5	−0.3	230°

Heliocentric Planet Charts for November and December





Presented here are two new charts intended to show the heliocentric and geocentric movements and positions of the naked-eye planets. The upper indicates the orbits of the "terrestrial" planets—Mercury, Venus, earth and Mars—and the lower chart shows the orbits of Jupiter and Saturn, with those of Mars and earth for reference. The orbital positions of the inner planets are shown for the 1st and 15th of each month, from Nov. 1 to Jan. 1, 1962. The positions of Jupiter and Saturn are shown only for Sept. 1st and Nov. 1st, as their motions are relatively slow. Orbits are to scale.

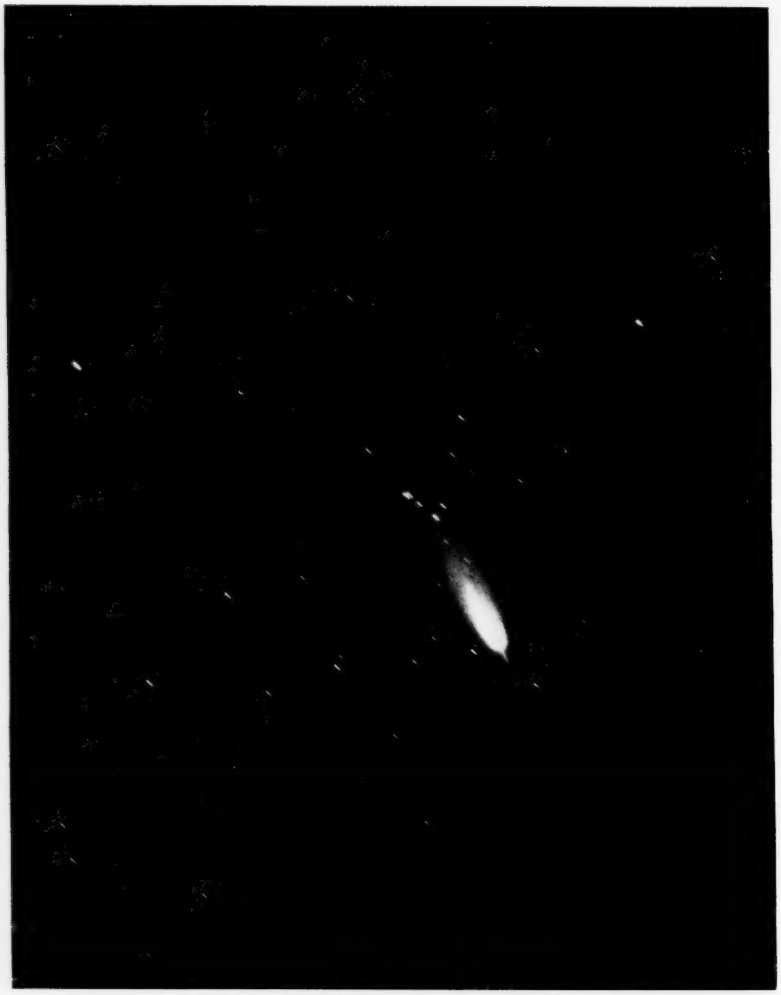
Scales of distance in astronomical units (mean distance from earth to sun: 92,900,000 miles) and millions of miles are included for each chart, and can be used to measure approximate distances between any pair of planets, or planets and the sun. The nodes are indicated so that one may determine upon which side of the ecliptic, north or south, a planet will be found. Moving eastward, a planet, having crossed the ascending node (☊), will be *north* of the ecliptic, until it reaches the descending node (☋), when it crosses to the *south* until it passes the ascending node again. Positions of perihelion (P) and aphelion (A)—closest and farthest distance from the sun—are indicated by the appropriate letter and a long tick.

Progress of the planetary rhythms can be followed with considerable exactitude from month to month. Their configurations — conjunctions, oppositions, elongations, passages of perihelia, for example — should be easily noted. The interested reader will discover much other useful information that can be gleaned from study of this regular new feature.

Heliocentric and Geocentric Longitudes

The heliocentric longitude (i.e., as seen from *sun*) of a planet at any time can be read from the charts by drawing a straight line from the center of the sun through the planet and intersecting the outer scale of longitude at the required point. Dates between those indicated for any planet can be interpolated, or estimated.

An example of this simple and useful calculation can be found on page 24 of the March-April issue.



One of the brightest and most interesting comets in recent times was Comet Arend-Roland, which appeared in the spring of 1957. Overnight it developed a spike-like sunward tail which disappeared after a few days. As the author explains, this effect was caused by material ejected from the comet's nucleus and observed from earth edge-on for several days. This photograph is reproduced through the courtesy of the Lick Observatory and was taken on the evening of April 25, 1957. Star trails indicate the sensible motion of the comet, on which the camera was guided.

COMETS WITH SUNWARD TAILS

By David M. Meisel

In April of 1957, Comet Arend-Roland made its sudden and striking appearance in the evening sky. During its first week of visibility it showed a very well developed main tail which spread as much as 45° away from the comet's head. Like many bright comets, this object had more than one tail, but the curious thing about this comet was the direction in which its second tail was pointing. It appeared to be directed *toward* the sun, instead of away from it. Although it is unusual for a comet's tail to point exactly in a direction opposite to the sun, if one accepts the solar repulsion theory of tail formation the tail should point approximately away from the sun.

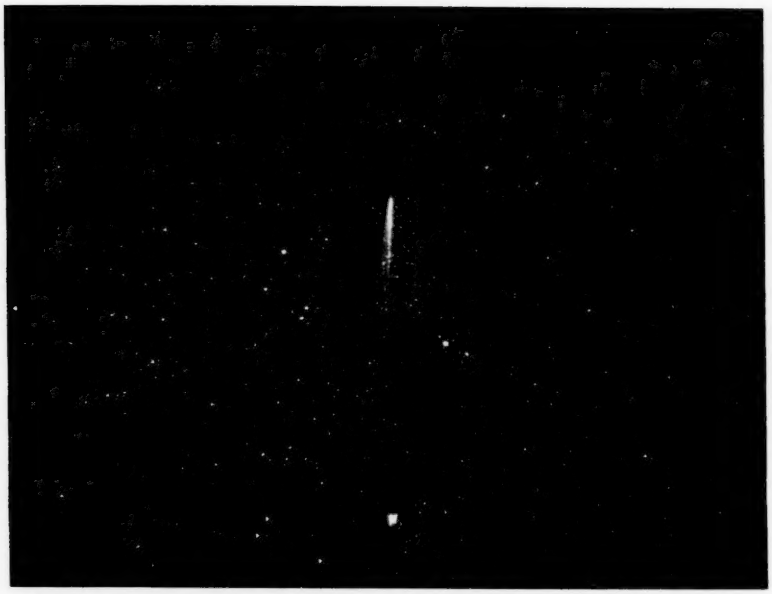
This summer—a little over four years later — another comet has shown a similar, although not as spectacular, "beard," or anti-tail. Thus, Comet Wilson 1961 added its name to the small list of comets displaying such anti-tails.

The explanation for the anti-tail is simple. It is a thin sheet of dust that has been ejected by some mechanism within the comet and gradually spreads out into the oribtal plane. Normally, this dust is very transparent, but when the earth passes through the plane of the comet's orbit, the sheet is seen edgewise and its feeble illumination is concentrated along a thin line—giving the "spike" appearance of the anti-tail. Seen from either side of the plane of the orbit of the comet, the tail is fan-like, looking somewhat like a "beard" attached to the coma. This released material drifts in an orbit similar to that of the comet, later becoming particles in the associated meteor stream in the comet's wake.

While the phenomenon was satisfactorily explained in 1877 by T. Bredichin of Moscow Observatory, in connection with Comet 1862 III, the nature of the ejection mechanism is still open to question. Undoubtedly the mechanism requires a fair amount of energy. Of the known processes occurring in cometary *comae*, only the explosive recombination of the fundamental constituents of the chemical compounds in the comet interior could produce the observed result.

In the case of the great comet of 1861, the anti-tail produced an annual tribute to the disintegration of its progenitor. Every year the earth intersects the orbit of this comet, producing the August Perseid meteor shower, the most dependable of the annual showers. There are many astronomers who do not accept the idea of the direct connection between the anti-tails and meteor showers. However, almost everyone has to agree that in some way the processes that produce the anti-tail and the meteor shower are intimately connected. The solution of one problem will lead to the ultimate solution of the other.

At the centennial of the production of the Perseid shower, sorry to say, we know very little more than Bredichin did. We, of the 20th century, may, however, live to see the day when man himself will actually invade the domain of the comet coma and observe the violent ejection of meteoric material.



On the morning of July 23, 1961, amateur astronomer and Pan-American navigator A. Stuart Wilson discovered and reported a naked-eye comet which suddenly appeared in the dawn sky. Comet Wilson was visible in the morning twilight for several weeks (see cover photo, Sept.-Oct. 1961 issue of this magazine), developing a faint anti-tail during the last week of July. This photo by Alan McClure of Los Angeles was taken on Aug. 1 using a 4 x 5 view camera with an f/2 Xenon lens and Royal-X Pan film (plus orange and polarizing filters to help minimize effect of bright moonlight). Tail was measured on negative at 12°, and extends upward from eastern horizon toward Capella and the Kids in this 10 minute exposure.

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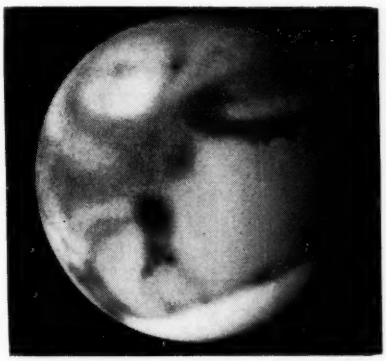

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BULLETIN

NEW COMET SEKI

Seki, a Japanese observer, discovered an 8th magnitude comet on the morning of Oct. 10, 1961, and Dr. Elizabeth Roemer of the U. S. Naval Observatory at Flagstaff feels that it may reach naked-eye visibility during late October and early November. Paul Ahnert at Sonneberg, Germany, reported it to be 7th magnitude on Oct. 14, with a 4° tail; Miss Roemer reported 7th magnitude on Oct. 15, while H. L. Giclas at Lowell estimated 6th on Oct. 14 using a different instrument. It was successfully observed in the U. S. Oct. 21 in Leo just west of Denebola.

A tentative ephemeris for Comet Seki was developed by Dr. Leland Cunningham and communicated by the Harvard College Observatory. Positions are for universal time at 0h on the dates given: Oct. 28: RA 11h 11m, Dec. 11° 52′; Nov. 1: 11h 06m, 9° 54′; Nov. 5: 10h 59m, 6° 15′; Nov. 9: 10h 45m, −1° 15′; Nov. 13: 10h 0m, −28° 14′. It will move south of Leo into the Crater-Sextans-Hydra area during early November and into the southern hemisphere. In early November Comet Seki should rise in the eastern sky shortly before 4:00 a.m. local standard time, making it a dawn object. Use field glasses or low powers to locate it. Observations can be sent to ALPO comet recorder David M. Meisel through this magazine.

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The Saturn nebula, sketched by author with a 4-inch at 250x, to bring out details. Even Messier overlooked this, although easy in finder.

Sky's Forgotten Objects

By JOHN H. MALLAS

IN THE LAST ISSUE, it was suggested that many objects in the sky show considerable visual detail. They may or may not be well known objects. In my survey of the heavens, I have found that, with a number of objects, the visual impressions are strikingly similar to their photographs: this usually is not true. Also, in the course of my observations, it became evident that many of the difficult objects labeled "for the photographic plate" or "reserved for the large telescope" can be seen in small apertures by careful observing. It is not necessarily true that faint objects can be viewed only with large telescopes or that they must be photographed to be seen.

To emphasize the two types of objects just mentioned, I have chosen to be included in this issue's list of off-trail objects, the Saturn nebula and the field around Cassiopeia. All the objects listed are well placed for viewing in November and December.

1. NGC 7009 21h 01m.4 −11°47'
Aquarius Planetary

The Saturn nebula—how Messier ever missed this object is a mystery. You cannot miss it in the finder! It is one of the very few nebulae in the sky which will allow all the magnification that seeing conditions will permit. The higher the power, the more of its details are seen.

It is a strange planetary for detail and shape. As shown in the drawing, a granular texture can be seen in three areas, the most intense being near what appears to be a star in a small scope. It gives the impression of a double exposure of two different nebulae, one piled on top of the other. Sometimes a "doughnut" shape can be seen, and at other times an oval nebula with extensions will make its appearance. The extensions are flares which stream outward on the sides (giving rise to its name) and fade suddenly into the sky background. Using 250x, a dark area can be seen at the center, and there is a suggestion of a smaller one. Your entire range of magnifications is recommended. Note the visual impression is almost identical to its photograph! It is 44″ x 26″ of arc in size, and the magnitudes of the

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nebula and the star are 8.4 and 11.7 respectively.

2. NGC 628 M74 1h 34m.0 +15° 32′
Pisces Galaxy

A difficult object for the 4-inch f/15 refractor, although visible in the finder. It is very similar to M33 in both visual and photographic details. It displays a star-like nucleus, and the casual observer could miss it completely! Perhaps the most interesting features of this galaxy are the very faint nodules surrounding the nucleus. They are not easy, and indirect viewing should be tried. Success will not come often in a small instrument, especially on nights of poor transparency. The overall impression is one of a spiral seen head on, with the nodules seen as brighter patches in the arms. A power of 25x is best, and no higher than 60x is recommended. This object is 8′ x 8′ in size and of magnitude 10.2.

This sketch of M74 in Pisces was made by the author and shows the bright nucleus and nodules visible in a small telescope. Magnification of 25x was used in drawing.

3. I59-63 0h 10m.7 60° 48′
Cassiopeia Nebula

The region surrounding Gamma Cassiopeiae is extremely rewarding for the telescopist. The rest of the column will be devoted to this area, for it offers a great deal of surprises.

While searching out the doubles in this area this viewer can not help but notice the irregular sky background surrounding Gamma Cassiopeiae. Greenish streaks could be seen radiating outward from the star, not often, but often enough to catch the eye. By indirect viewing, the outline as shown in the sketch was clearly seen. I have only seen it on two occasions, and both nights were excellent. The texture is very soft, and the nebulosity becomes more intense in brightness near the star. Its appearance is like a thin oil film floating on a water surface. It has a greenish hue, intermixed with black. Use the lowest powers available. The shapes of these two nebulae are highly irregular. I liken this nebula to "rabbit's ears."

4. Gamma Cassiopeiae 0h 10m.7 60° 48′
Double star and variable

Number 1028 in Burnham's list of doubles. The companion is very faint compared to the primary (11.0), and is extremely difficult. It was not positively identified in a 4-inch at 375x. A larger glass should show it as it is not especially close—2° at 248° (1956). The nebular "halo" of Gamma is extended in the direction of the companion but the companion was not seen. The primary is variable and has the distinction of being classified as a quasi-nova (Eta Carinae type). It has varied in

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brightness from 1.6 to 3.0 magnitudes. Its period is not predictable. It is likely that the nebulosity in which it is embedded influences its change in brightness. Either the star was "born" in the cloud or it is "tunneling" through it.

5. *B*1099 0h 53m.8 60° 6′
Double star Cassiopeia

A beauty for the small glass. Use medium to high powers. Magnitudes are 3.6 and 7.5, separated by 10″ at 293° (1955). The colors are golden and lilac. The color of the primary agrees well with its spectral class (dF9).

6. Eta Cassiopeiae 0h 46m.1 57° 33′
Double Star (Struve 60)

Directly below Gamma, this double can be found in the same low power field. It is an extremely close binary system with a period of 76.5 years. Its combined magnitude is 5.54; the components are 6.0 and 6.7. The maximum measured distance known to the author comes from the Aitken list: 0″34 at 358° (1922). In the 4-inch, using 375x, it appeared as a pear-shaped image and there was no doubt to this viewer that it was a close double. Its colors are pale yellow and blue. Also note in the same field a faint double, the colors appearing to be red and violet.

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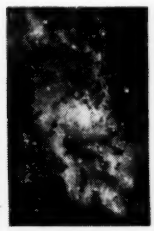
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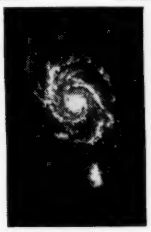
4. GREAT NEBULA IN ANDROMEDA

6. SOUTHERN SECTOR OF MOON

From Mount Wilson and Palomar, Yerkes and Lick Observatories come the classical exposures from which these dramatic 2 foot by 3 foot photographic quality prints were made.

8. SPIRAL NEBULA IN ANDROMEDA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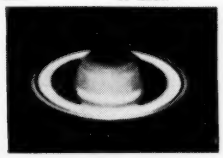
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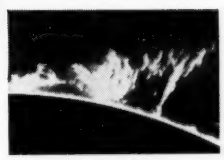
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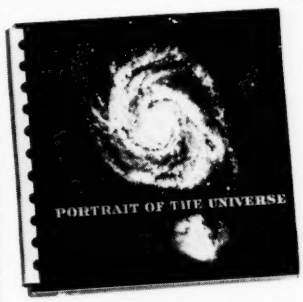

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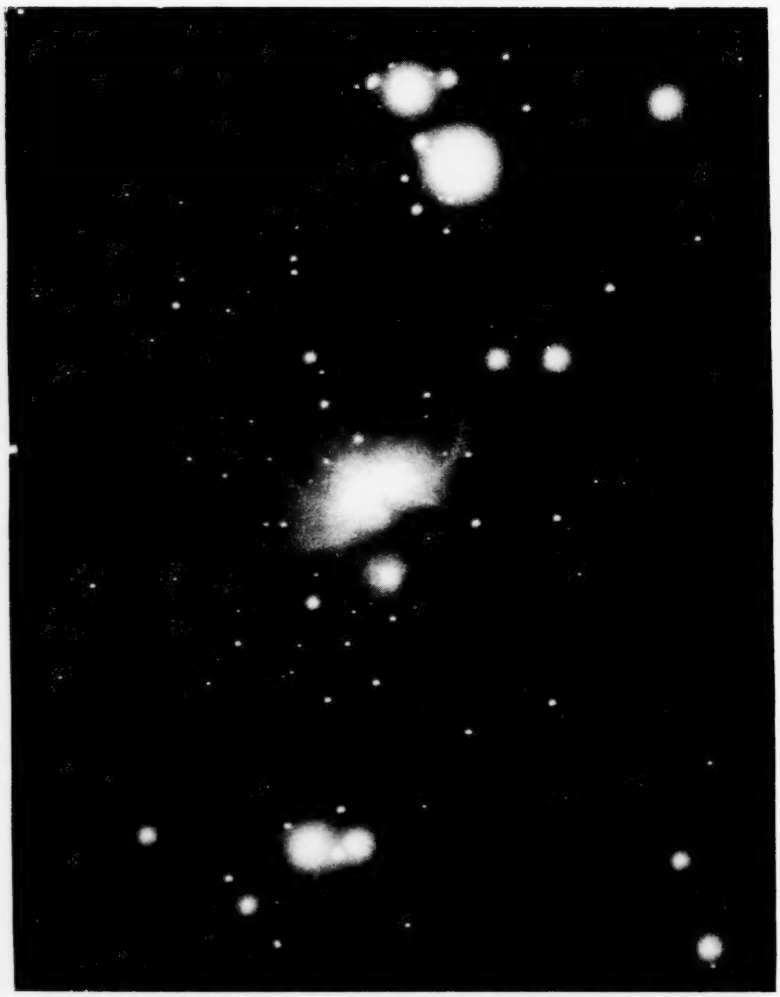
OUTER SPACE PHOTOGRAPHY

DR. HENRY E. PAUL

BIG PICTURES WITH SMALL INSTRUMENTS

WE'VE SPENT CONSIDERABLE effort in this column to encourage more amateur astronomers to convert their telescopes to astrographic cameras and begin star-shooting. It's our attitude that a great variety of cameras can be successfully used to photograph the many objects in the sky within their reach. Perhaps the word "astrographic" alone has scared more folks away from celestial snapshooting than any other single factor. In spite of this, amateur astronomers and amateur photographers both are moving into this interesting field, and the editor of this magazine tells me that sheafs of celestial photos, equipment pictures and letters describing techniques and apparatus are flowing in each week. This writer will select from among those photos and pieces of equipment which would be of greatest interest to the amateur.

However, unless otherwise indicated by the submitting source, interesting photos will be held for later use in illustrating articles: photos of telescopes and mounts of unusual interest will be held for discussion in the telescope section of this magazine. (Please—don't undo your hours of hard work: send all photos in strong envelopes with corrugated stiffeners just smaller than the envelope itself. Several unusable photos have arrived which would have been excellent if they hadn't have been creased or defaced in the mails!)



This 12-minute exposure of the Orion nebula was made by Mr. Jacobs using 4 x 5 Royal -X Pan and a 24" focal length f/6 surplus camera lens stopped down to f/8. The mounting of his instruments is discussed in detail in the accompanying article.

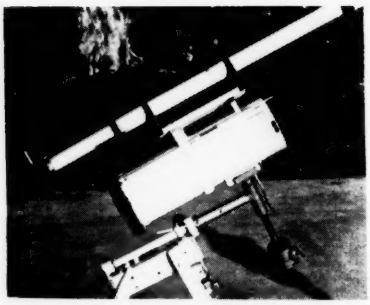


Fig. 1. Original mounting for photographic set-up used by Mr. J. H. Jacobs of Fort Myers, Fla. Shown is guide scope and 4-inch f/6 surplus camera lens used to make photo below.

This time we have selected from among a number of excellent submissions the work of Mr. J. H. Jacobs of Fort Myers, Fla. We cannot help but be impressed by the enthusiasm, careful detail and technical quality of Mr. Jacobs' work. His are unusual because of the flexibility of his set-up and his excellent results with a small-aperture reflector.

This photo of star in the Belt of Orion, made with 3-inch reflector, shows excellent star images obtained with Jacob's guiding system. Bright star is over-exposed. Enlarged from a 35mm negative.

Fig. 1 shows his original mounting which he has used for nearly two years. The 24" efl f/6 camera lens shown can be replaced with a small 3-inch reflector or a 3-inch reflector-

(Continued on page 34)

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From An Observer

On clear "good-seeing" nights my Dynascope easily reveals the Alpine Valley and the Straight Wall on the Moon, as well as three peaks in the floor of the Plato ring plain. It will split the star Mizar into its major components clearly. It will separate Saturn's rings and show six bands on the face of Jupiter. Also it will project a two-foot diameter disk of the sun showing sunspots in vivid detail . . . as an Englishman might express it, "Dynascope optics are a little bit of all right." —VICTOR W. KILLICK, in charge of Astronomical Observatory, Sacramento Junior College, Calif.

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. . . I have had many years of experience in astronomy, and as junior leader here in Atlanta I always recommend Dynascope. —LEONARD B. ABBEY, Jr., Decatur, Ga.

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. . . For the price you ask, I do not believe that it can be equaled in any way. The oculars are excellent, and the entire instrument shows careful workmanship. How you do it is beyond me. —G. N. JOHNSTONE, Albuquerque, N.M.

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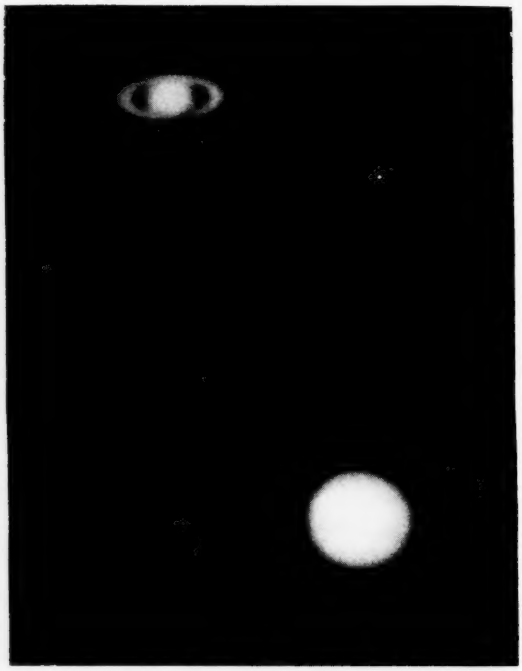

This composite photograph of Saturn and Jupiter was made by Mr. Jacobs with a 35mm camera and Plus-X film using a guided 3-inch reflecting telescope. On the original prints several belts are visible on Jupiter and Saturn, as well as a hint of Cassini's division in Saturn's rings. The camera position was after the Jupiter exposure (8 seconds) so that the exposure of Saturn (18 seconds) could be included on the same negative. Careful processing allowed a 15x enlargement from the 35mm negative.

(Continued from page 32)

camera. The mount has wooden legs and a clock drive attached to the polar axis through a rack and pinion. The excellent photos shown here were taken with this unit, but Mr. Jacobs has now constructed an entirely new arrangement—let's quote directly from his letter:

"The enclosed photos (Fig. 2 and 3) show my newly constructed rig which I am just lately trying out, and I believe it is going to prove very satisfactory. It is solidly built of welded 2" and 2½" tubing, permanently set to the 23½° latitude of Fort Myers. The wheels make it portable, but when in use they are raised and the legs rest on the ground—on a screw point on one side, on an adjustable pad on the other, and on a hinge bearing on a block. The axis shaft is of 2½" tubing, supported on large ball bearings. Permanently installed inside this polar axis is a 6x scope with offset cross-hairs for accurately alignment of the axis on Polaris. I have setting circles ready but they are not yet mounted.

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Fig. 2. Mr. Jacobs is currently running his new mounting (shown with his 3" homemade reflector) through a "shakedown cruise," and expects it to perform even better than original rig.

Figure 3 (below) shows details of the clock drive and slow motion correction controls. These consist of a small, 1 rpm synchronous motor that turns the gear shown, which in turn moves the threaded shaft connected at the upper end to the driving arm of the polar axle. The four spokes are used to move the right ascension slow-motion control, which consistof a sleeve with threads of 16 per inch in one end and 18 per inch in the other. Turning this thread gives a very fine, slow movement for corrective changes. The three-spoked

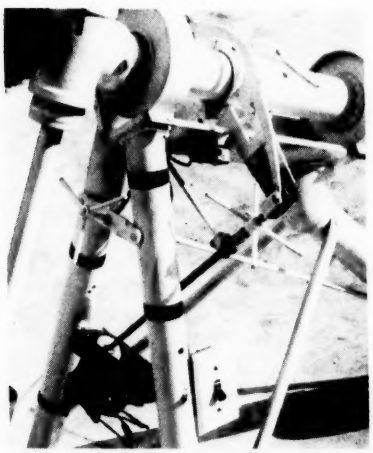

Fig. 3. This photo shows details of the clock-drive and slow-motion assembly. Four-spoked wheel at center right affords fine control of right ascension, important in astrophotography.

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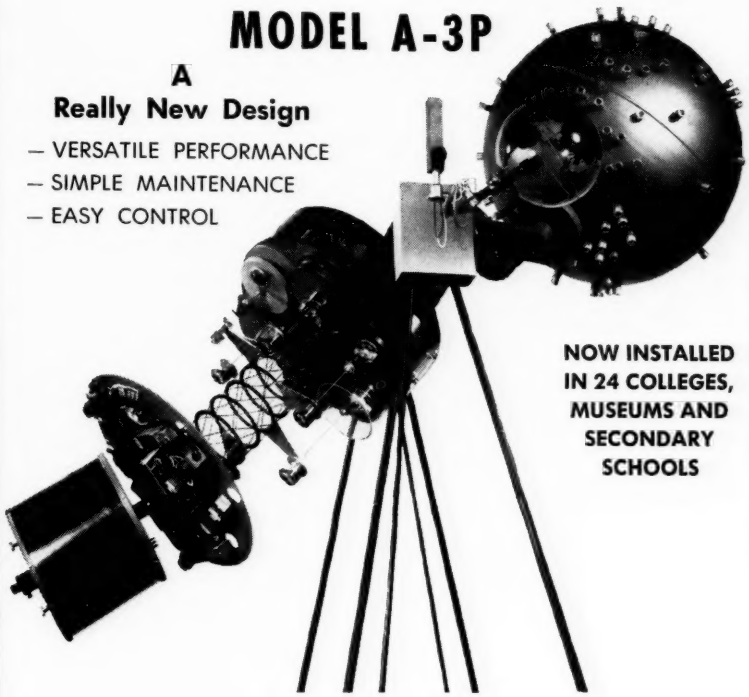

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hub moves the back leg-hinge for occasionally needed declination correction.

"Note the tapered arm connecting the screw junction and back over axis shaft where it connects, through an adjustable linkage, to the brackets shown in the accompanying photo (Fig. 4). This is a very important feature of the drive, as it imparts an almost constant rate of travel to the polar axis shaft throughout the two-hour period. At this time resetting is accomplished by moving the junction-point of the drive in or out as required to compensate for change in angle as the arm lowers. A small ball-bearing moves in the slotted arm to reduce friction at this point.

"One photo (Fig. 5) shows the 35mm camera mounting on the long slotted arm. It is an old folding-camera body with the bellows removed, and to which I have mounted a home-constructed reflex mirror. Using the 50mm Tessar lens as an eyepiece (as shown) and with the camera at that position I get 7/8th-inch diameter image of the moon on the film. Occasionally I use a 40mm camera lens, and with the camera all the way back I get what would amount to a 4-inch diameter lunar image. This is excellent for crater close-ups and planetary photography. A tube from the lens to the camera is used when shooting."

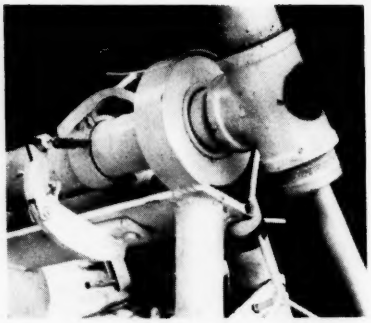

Fig. 4. Rod connected to clock-drive extension shown in Fig. 3 is tied to an adjustable linkage complex that imparts a nearly constant rate of travel in right ascension.

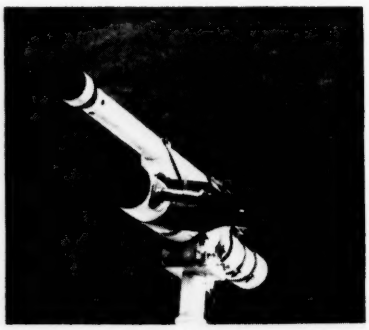

Fig. 5. The slotted bracket extending out to right of eyepiece adapter holds a homemade reflex camera using a 50mm Tessar lens. Using this lens as an eyepiece, Mr. Jacobs gets a 7/8-inch image of the moon.

Mr. Jacobs' guiding 'scope has a 2-inch objective mounted in a 50" glass-resin-covered tube. The 24" f/6 camera is mounted in a galvanized metal tube which is designed to adapt at the rear either to an eyepiece, a 35mm camera or a 4 x 5 plate holder.

Mr. Jacobs wondered if we found all of his detail boring. How could anyone be bored with such fine work? His celestial photographs on these pages speak for themselves, especially when one realizes the modest apertures with which they were made.

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YOUR TELESCOPE AND MINE

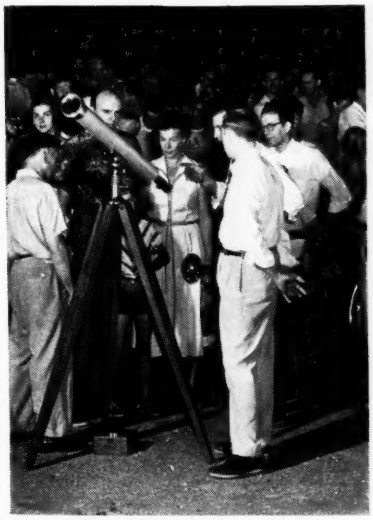
By Tom Cave

THE AMATEUR SELECTS A TELESCOPE

This writer recently received a letter from a long-time reader of this magazine who wishes to remain anonymous. He writes: I have been a regular subscriber to your magazine for many years and have been forced until quite recently to being mainly a member of that large body of amateurs who call themselves "armchair astronomers." My professional background is in physical science with a graduate degree, but until recently I have had to confine my equipment to a small but excellent 2½-inch refractor of famous make. Having always lived until now in a large Eastern city plagued by bad weather and poor seeing, I have now moved to the suburbs and have the room and dark sky for a much larger telescope. My main desire now is to own a first-quality, permanently mounted and housed telescope that is large enough in aperture to observe critically the moon, planets and close double stars, and perhaps engage in regular observing programs. What size, type and focal length will be best for me?"

In answering this question certain factors must first be carefully considered. Since this reader's primary requirement is to possess a telescope capable of high resolution and finest definition, with sufficient light grasp to participate in lunar, planetary and double star programs, he should select as his minimum aperture nothing smaller than 6 inches. An 8- to 12-inch telescope would serve him better, provided his local "seeing" conditions (as opposed to mere transparency and dark sky) are good enough to afford a reasonable number of nights per year on which he could obtain sharp, clear views of the planets and close doubles with magnifications from 250-500 power. This range of magnifications is normally employed by planetary and double-star observers on 6- to 12-inch instruments in regular observing programs. Since it is this writer's experience that most part of the United States—especially in suburban and rural areas—meet these requirements, I would strongly recommend an instrument in the larger, 8- to 12-inch aperture range.

Refractors have several advantages —and several disadvantages. Many of the disadvantages do not exist if you have the money to purchase, house and mount the instrument. More about that in a moment. Most



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refractors are about f/15 in focal ratio (15 times the aperture of the objective lens), although some or even greater reducing even further the bothersome secondary spectrum effect inherent in refractors. There is little question, however, that a fine refractor will give better star images

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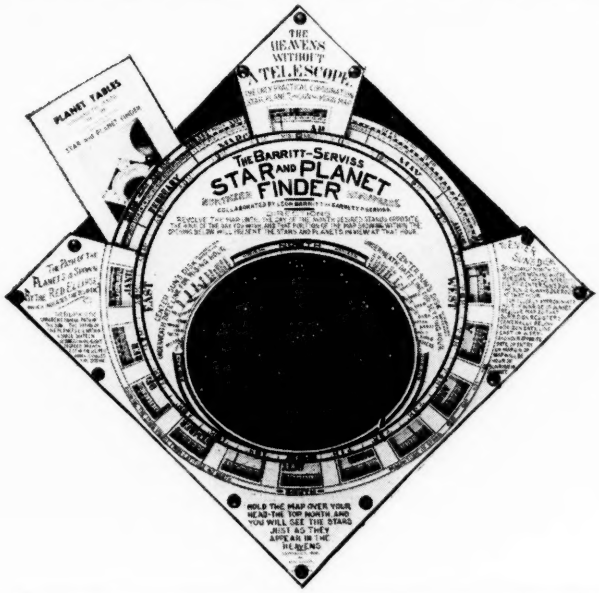
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and diffraction rings than an equivalent reflector under poor to moderate seeing conditions, and this has made the refractor the choice of serious double star observers. (Also, in micrometric measurements of double stars, the stability of the optical system in the refractor against the possibility of disalignment of a reflectors optical train is an added consideration.)

However, under good to excellent seeing conditions, a high-quality reflector will equal the performance of the same aperture refractor on the moon, planets, clusters and galaxies, and will give a good account of itself on doubles. It should also give equally "classic" star images—under good conditions. And a reflector, of course, has the advantage of a 50% saving on tube length (inch for inch, normal focal ratio), and the obvious plus—economy.

In regard to the dollar cost of reflectors versus refractors, the reflector is, of course, very much less expensive, inch for inch. While top-quality refracting telescopes of 6-inch aperture may cost from about $2,000 to $6,000 (depending upon mounting, accessories, and maker's name to a considerable extent), occasionally a truly fine old second-hand 6-inch or larger refractor may be purchased for much less money. This writer personally knows of two 6-inch Alvan Clark refractors of the very finest quality which were purchased second-hand during the last few years for a very small fraction of the previously quoted new refractor prices. While such refractors are often in deplorable mechanical condition and require considerable work to restore to best condition, the restoration cost is comparatively small and the work is always an interesting project and the results highly rewarding when the job is finished. Larger old refractors of 7- or 8-inches and even larger are occasionally to be found for but a small fraction of their original cost. The potential purchaser should always be sure the objective lens is in good performance condition and that the mounting is not beyond the possibilities of full repair before paying any price.

A SHIP'S OFFICER from Boston, Mass., Mr. A. L. Anderson, writes, "What would be the cost of a rich-field reflector of the off-axis type of 6-inches aperture and 30" focal length?" In reality there is no practical reason for making a short-focal-length reflector of the RFT type in an off-axis style. A RFT is fundamentally designed to give a very wide field of view with a low power—the end result being a telescope which will show at one glance the greatest number of stars in one field

Conventional richest-field telescope (4¼-inch) made by Leonard Megginson (above) of St. Louis affords many relaxed hours of star field

of view. On-axis conventional RFT's in the 4- to 6-inch range are obtainable for about $50-$125 on the market today. Off-axis reflectors, even of long focal ratio, are very expensive and difficult to make. To this writer's knowledge none are available on the American commercial market today.

MR. FRED WYBURN, Red Bluff, Calif., has recently written inquiring about the comparative costs of new refractor objectives. He asks, "One firm prices its 6-inch objective at $720, another at around $400. I'm wondering if there is a difference in the defining and resolving power of these?" In answering this inquiry (without knowing the firm names) the writer wishes to point out that the cost of imported, matched sets of the finest crown and flint raw blanks for a refractor *can* cost the optician making the lens as much as about $200, with the additional work of

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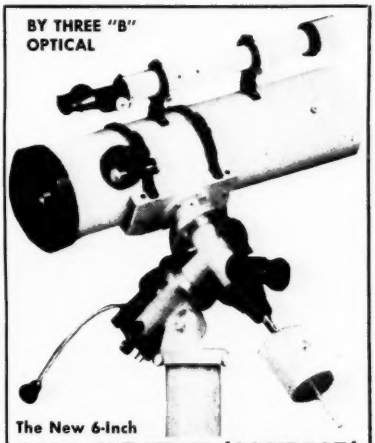

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This 6-inch Cassegrain-type Maksutov telescope was demonstrated at Mid-States convention of Astronomical League by Lauran Kilmer of the Tulsa Astronomical Society, one of several being made in a club project. This front view shows thin corrector lens and bright mirror at bottom of tube. Flat mirror between fork trunnions directs light from finder into the telescope's eyepiece. (Photo by R. E. Cox.)

grinding. polishing and figuring the lenses. plus coating and cell running the final price of the lens easily to $700 to $1,000.

However. some first-class American opticians prefer to purchase the finest domestic raw blanks. which rarely cost more than $60 to $90 per set. The end result in performance between foreign and domestic glasses is identical. provided that the optician is skilled in removing the slight differences in density that exist in many domestic blanks. This requires skillful localized figuring which is sometimes done by the worker with his thumb. and is more often required when working domestic crown and flint than with the best European or English glass. The lower cost of the blanks made in this country often reduces the cost of the final objective several hundred dollars.

Questions on telescopes and mirror-grinding should be sent to Mr. Cave c/o this magazine. Urgent queries will be answered directly by the author, then perhaps used later in his regular column.

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Catadioptric Telescopes—What And Why

By Robert E. Cox

What is a catadioptric telescope and why is it considered to be a superior instrument by many serious astronomical observers? A simple explanation is that its design—a combination of lens *and* mirror—yields unusually fine definition, either photographically or visually, with a reduction in the undesirable aberrations found in regular instruments. In order to expand this statement further it is necessary to be conscious of the defects that exist in standard instruments.

The common refractor objective consists of two lenses. either cemented together in sizes up to 3 inches. and air-spaced in objectives over this size. The glasses are carefully chosen so that the outer element (of crown glass) has the color it introduces into an image "cancelled out" by the inner element (of flint glass). Unfortunately. it is only possible to correct the color for two specific wavelengths of light. usually the C and F lines. the others falling inside and outside this compromise focus. The remaining color is the secondary, or residual. spectrum. On small telescopes of amateur size. modern glass and design methods have reduced this color residual to a point where it is just about invisible in a sharply focused refractor and it is not noticeable unless one deliberately looks for it. However, inside and outside the focus the images reveal the "color fringe" characteristics of these instruments.

The reflecting telescope. the most

popular of amateur built instruments. is inherently a color-free system, both visually and photographically; however, it suffers from the image-distorting defects of coma and astigmatism, which limit its useful field. Another bothersome defect is the open tube of the reflecting telescope, which causes image-disturbing air currents in the tube of the instrument that limit optimum resolution and make necessary a "cooling-off period" between the time an instrument is taken out for observing and the moment when temperature equalization is reached. Often on a night with rapid changes or falling or rising temperatures complete steadiness is never obtained.

While the four surfaces of a refractor objective are spherical in figure, the surface of a mirror must be altered to a conic section—a paraboloid—a delicate task involving careful workmanship. The change in the surface of a 6-inch, f/8 reflector from a sphere to a paraboloid involves a deepening of the curve by 11.4 millionths of an inch! For specialized work, the amateur and professional often use a compound mirror system, the commonest of which is the Cassegrainian telescope. This combination of a large concave paraboloidal mirror and a smaller convex hyperboloid involves complicated figuring and expert fabricating techniques. There is a somewhat simpler system, the Dall-Kirkham, in which the primary mirror is left undercorrected or elliptical, while the smaller secondary mirror can then be left spherical, but is it still an involved instrument for the beginner to construct.

Rear view of Tulsa Maksutov showing massive yoke mount, diagonal eyepiece assembly and viewing port at bottom of tube for direct photography through the instrument. Entire lower casing rotates for convenient positioning of eyepieces. (Photo by author.)

The catadioptric (literally, "two opposed types of optics") telescope designation includes any instrument that uses a combination of lens and mirror to achieve optical excellence. One of the best known is the photographic Schmidt camera, the largest of which is the 48-inch instrument on Mt. Palomar. Except under unusual circumstances the Schmidt is not a visual instrument.

The best known and most popular of visual catadioptric telescopes is the Maksutov. Basically this instrument consists of a thin shell of glass and a concave reflecting mirror, the

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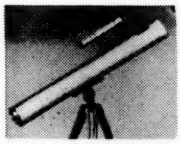

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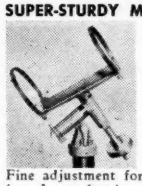

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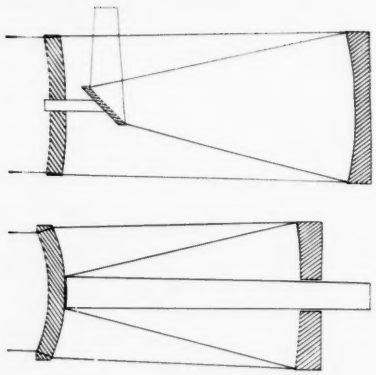

(Top) Newtonian form of Maksutov telescope, comprised of thin shell of optical glass and mirror, both surfaces being spherical. The diagonal flat is mounted on a shaft which passes through either lens or mirror, eliminating spider diffraction and improving definition.

(Bottom) Cassegrain form of Maksutov has steep curves on corrector lens, and secondary mirror is usually aluminized spot on inside surface of lens. Unless final focal ratio is large (+f/20), aspherical figuring of mirror or lens is required for optimum performance.

shell, or corrector, being located at the top end of the tube, sealing the optical train from troublesome air currents and simplifying the figure

An important advantage of the catadioptric is that its color residual is about 1/800th that of the best refractor, and therefore invisible, existing only in theory. This is accomplished by using only one piece of glass—the correcting lens or shell—reducing cost and simplifying construction.

The Newtonian-focus form of this instrument is shown at the top of the accompanying diagram. The curves are almost concentric on the correcting lens' surface and its action nearly approaches that of a plane-parallel glass window. However, the slight difference in curves causes it to differ from a window and introduces a small amount of spherical aberration—just enough to balance the correction which would normally be placed on the primary mirror, which can now have a spherical figure. As shown, the small flat or diagonal mirror is often mounted on a shaft passing through the corrector-plate itself. This eliminates supporting struts, reducing scattered light and the bothersome "spider" diffraction found in the regular Newtonian.

The Maksutov can also be designed to operate as a modified Cassegrain telescope, as illustrated, in the lower diagram, and in a majority of cases the secondary mirror is an aluminized spot that is an integral part of the rear surface of the correcting lens. It is also possible to make the secondary a small mirror, either cemented on the back of the lens or mounted on a shaft through the glass as in the Newtonian form.

The Maksutov telescope is not an instrument to be built by the beginner. The curves are steep and other requirements of the design are also critical because of the close tolerances demanded. If an amateur with several regular mirrors to his credit contemplates such a telescope, it is recommended that the Newtonian form be built instead of the short-tube Cassegrain. The shallower curves will be easier to handle and the success of such a project will be much more likely than with a complicated, hard-to-figure compound instrument. A good f/4 Newtonian-Maksutov can easily be increased to f/12 with a high-quality Barlow lens for high-power applications, and this is the recommended approach for the average amateur.

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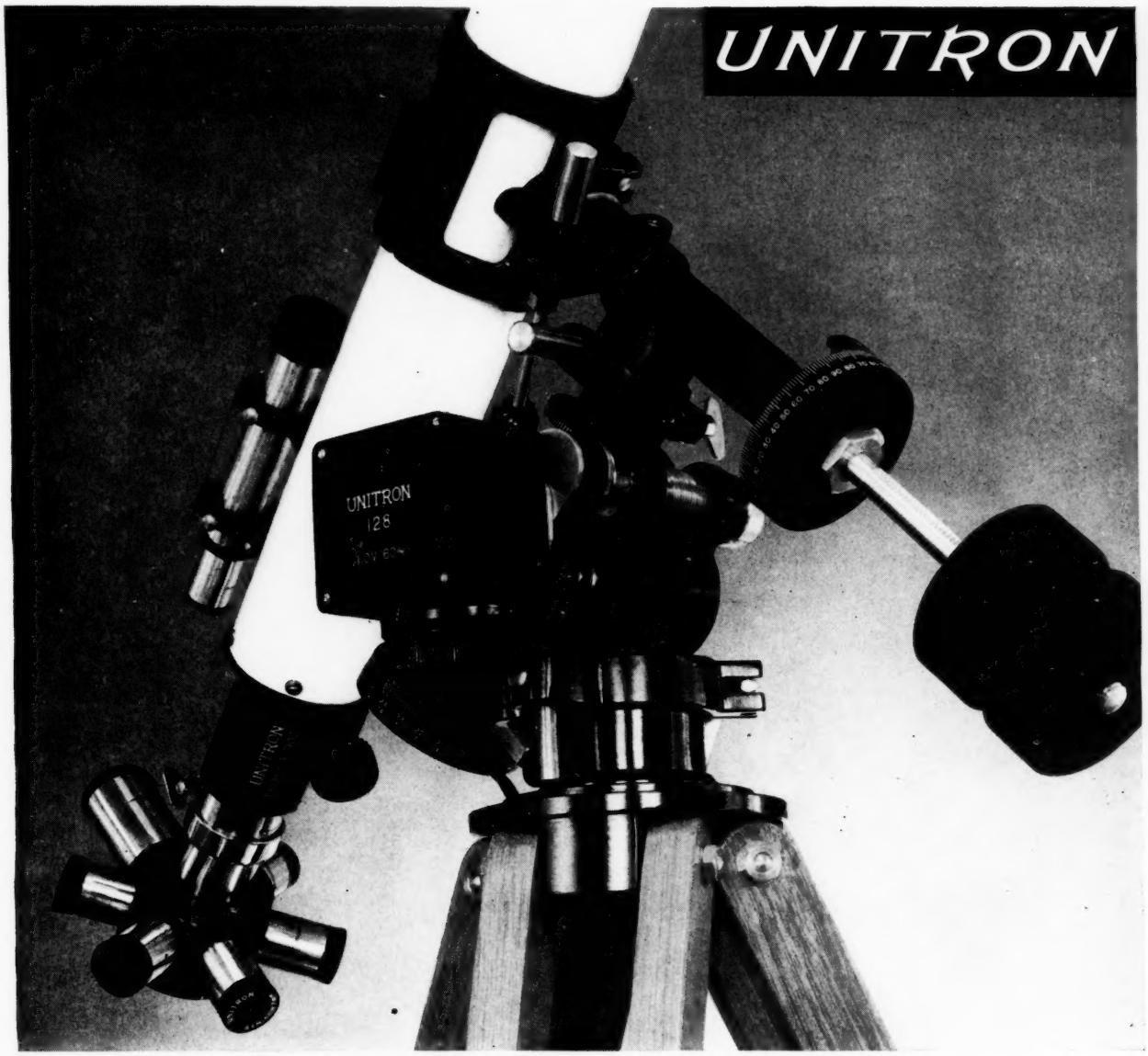

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